

Effect of a chair and computer screen height adjustment on the neck and upper back musculoskeletal symptoms in an office worker

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DECLARATION

DECLARATION

Declaration

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ABSTRACT:

Aims: To assess the effect of a chair and computer screen height adjustment on the neck and upper back musculoskeletal symptoms in an office worker.

Methods: An N=1 study was conducted using the ABC design. Ethics approval was obtained for the study and the participant provided informed written consent. The participant was assessed over three four week phases as she performed her habitual computer work. The outcome measures assessed during the three phases were the pain intensity and perceived sitting comfort. The three phases were named the baseline, intervention and wash-out phases. During the baseline phase, the outcome measures were obtained at the participant's habitual work station. The intervention phase involved a vertical adjustment of the chair and computer screen height. The wash-out phase allowed the participant to adjust the chair and computer screen height to their choice. A follow-up interview was conducted with the participant three months after completion of the study. The mean values and the ranges of the pain intensity and perceived comfort were obtained and compared. The data collected was captured on a Microsoft Excel 2010 spread sheet, where after the data was tabulated and presented graphically.

Results: The mean pain intensity of the participant increased slightly during the intervention phase in comparison to the baseline phase, but remained stable during the wash-out phase. The mean perceived sitting comfort deteriorated initially during the intervention phase, but improved later during the intervention phase and showed greater improvement during the wash out phase. The perceived sitting comfort showed more improvement than the pain intensity during the washout phase. Both the pain intensity and perceived sitting comfort showed improvement at the three months follow up assessment, post completion of the study.

Conclusion: The vertical height adjustment of the chair and the VDT did not improve the participant's pain intensity and perceived sitting comfort when compared to the participant's habitual workstation parameters. The findings do not favour the horizontal viewing angle. The findings of this study however support the use of 'slightly below horizontal' viewing angle as being conducive to reduce the pain intensity and improve the sitting comfort of an office worker.

OPSOMMING

Doelstelling: Om die effek te bepaal van die hoogte aanpassing van die stoel en rekenaarskerm op die nek en bo-rug muskuloskeletale simptome van 'n kantoorwerker.

Metodes: 'n N=1 studie was uitgevoer deur gebruik te maak van die ABC ontwerp. Etiese goedkeuring was verkry vir die studie en die deelnemer het ingeligte skriftelike toestemming verleen. Die deelnemer was ge-evalueer oor drie vier week-lange fases terwyl sy haar gewone rekenaarwerk verrig het. Die uitkomstmetings ge-evalueer tydens die drie fases was pyn intensiteit en waargenome sitgemak. Die drie fases was genoem die basislyn, intervensie en uitwas fases. Gedurende die basislyn fase was die uitkomstmetings by die deelnemer se gewone werkstasie ingevorder. Die intervensie fase het 'n vertikale aanpassing van die stoel en rekenaarskerm behels. Die uitwas fase het die deelnemer toegelaat om haar stoel en rekenaarskerm se hoogte aan te pas volgens haar keuse. 'n Opvolg onderhoud was gevoer met die deelnemer drie maande na die voltooiing van die studie. Die resultate was vasgelê op 'n Microsoft Excel 2010 data bladsy, waarna die data getabuleer en grafies uitgebeeld is.

Resultate: Die gemiddelde pyn intensiteit van die deelnemer het effens toegeneem tydens die intervensie fase in vergelyking met die basislyn fase, maar het stabiel gebly tydens die uitwas fase. Die gemiddelde waargenome sitgemak het aanvanklik verswak tydens die intervensie fase, maar het later verbeter tydens die intervensie fase en het aangehou verbeter tydens die uitwas fase. Die waargenome sitgemak het groter verbetering getoon as die pyn intensiteit tydens die uitwas fase. Beide pyn intensiteit en waargenome sitgemak het verbetering getoon by die drie maande opvolg evaluasie, na voltooiing van die studie.

Gevolgtrekking. Die vertikale hoogte aanpassing van die stoel en rekenaarskerm het nie die deelnemer se pyn intensiteit en waargenome sitgemak in vergelyking met die deelnemer se gewone werkstasie parameters verbeter nie. Hierdie bevindinge is nie ten voordeel van die horisontale kykhoek nie. Nietemin, ondersteun die bevindinge van hierdie studie die gebruik van die 'effens onder die horisontale'

kykhoek as bevorderend om die pyn intensiteit te verminder en die sitgemak van 'n kantoorwerker te verbeter.

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LIST OF ABBREVIATIONS

WRMSDs	Work related musculoskeletal disorders
WHO	World Health Organisation
OSHA	Occupational Safety and Health Administration
NIOSH	National Institute of Occupational Safety and Health
VDT	Visual display terminal
EMG	Electromyography
PC SAFE	Personal Computer Self Adjusting Functional Ergonomics
VAS	Visual Analog Scale
MCID	Minimal clinically important difference
ROM	Range of motion
CES	Cervical Erector Spinae
UT	Upper Trapezius
MVC	Maximum voluntary contraction
ICU	Intensive care unit
HIV/AIDS	Human immunodeficiency virus Acquired immune deficiency syndrome

CHAPTER 1: LITERATURE REVIEW

1.1 Introduction:

The aim of this literature review was to provide insight into both the prevalence and population affected by upper quadrant musculoskeletal disorders, specifically focussing in on office workers. The computer user's posture with respect to anatomy and patho-physiological changes is described. Further information is provided regarding the common risk factors and various management strategies that have been implemented to reduce and prevent the upper quadrant musculoskeletal disorders.

To obtain relevant information, the following search engines were accessed through the library of Stellenbosch University: The Cochrane Library, Science Direct, Google Scholar, Pubmed and Pedro. The key words used were: 'neck pain'; 'upper back pain'; 'computer related musculoskeletal symptoms'; 'workplace interventions'; 'workplace ergonomics'; 'workplace biomechanics'; 'chair intervention'; 'VDT interventions'. The search was limited to full text journal publications in English. The obtained articles were searched to provide further references through pearling. The literature search was conducted between May 2013 and May 2014.

1.2 Work related musculoskeletal disorders: (WRMSDs)

Work related musculoskeletal disorders (WRMSDs) continue to be a major cause for disability among workers worldwide (Nastasia, Coutu, & Tcaciuc, 2014). WRMSD's are considered to be the most common form of musculoskeletal disorders which appear to show an increasing threat and prevalence among workers worldwide. These disorders are reported to parallel and surpass the HIV/ AIDS burden (Bradshaw et al., 2003) becoming the more common and persistent complaint.

In developing countries musculoskeletal disorders are commonly overlooked by researchers due to the apparent urgency of investigating infectious diseases and the lack of sufficient funding to support large research projects (Adebajo., 1995; Bradshaw et al., 2003). There appears to be a paucity of information relating to the prevalence and functional consequences of musculoskeletal disorders in South Africa (Parker & Jelsma, 2010).

In 2006, the South African Department of Health reported that 30% of the consultations at Primary Health Care Services were regarding musculoskeletal complaints (Gran, 2003). In 2010 the prevalence of musculoskeletal disorders in a primary health care facility was reported to be 36% (Parker & Jelsma, 2010). The prevalence of chronic musculoskeletal pain, which is a consequence of musculoskeletal disorders, was 30% in Norway, 18% in Netherlands, 21% in Austria and 15% in France (Brooks, 2005).

1.3 Work trends and computer use:

The physical demands of work have altered in several ways with an increase in office based jobs (Groenesteijn et al., 2012). Forty seven percent of employees in the European Union perform sitting jobs, predominantly in offices (Groenesteijn et al., 2012). Employees perform most tasks seated behind a desk, leading to sedentary and repetitive movements (Hoeben & Louw, 2014; Lindegard, Karlberg, Tornqvist, Toomingas, & Hagberg, 2005; Tornqvist, Hagberg, Hagman, Risberg, & Toomingas, 2009). The demands, productivity, time deadlines and work output required in the workplace are also high, therefore the necessity of a computerised workstation is essential to measure up to the demands and competition (Griffiths, Mackey, & Adamson, 2007; Korhonen et al., 2003; Senhal, 2001) .

There has been a drastic increase in computer use over the years both at work and for leisure purposes (Gerr, Marcus, & Monteilh, 2004). Half the households in affluent countries have a computer at home (Straker, Limerick, Skoss, & Maslen, 2008 b). Computer use at home by adults and children has increased over the past decade, gaining popularity for social communication and entertainment (Gerr et al., 2004; Straker et al., 2008 a).

1.4 Upper Quadrant Work Related Musculoskeletal Disorders:

Due to the increase in frequency, intensity and popularity of computer use both for recreational as well as work purposes, the incidence of work-related illnesses and injuries have increased (Senhal, 2001). Computer work is generally more sedentary and requires high cognitive processing and mental attention (Johnston, Jull, Souvlis, & Jimmieson, 2010). The predominantly seated postures that are adopted while at work (Andersen et al., 2010) are strongly associated with an increase in

musculoskeletal symptoms in computer users (Blatter & Bongers, 2002). Upper quadrant work related musculoskeletal disorders usually manifest themselves as pain, discomfort, muscle tension and disability. The neck, upper thoracic and shoulder region are reported to be the most commonly affected areas (Hakala et al., 2010; Wahlstrom, Hagberg, Toomingas, & Tornqvist, 2004).

1.4.1 Prevalence of Upper Quadrant Work Related Musculoskeletal Disorders:

The prevalence of neck and upper back pain has been increasing in recent years (Aas et al., 2011), with the lifetime prevalence of neck pain in the general population being over 70%, with a point prevalence of between 12-34% (Cagnie, Daneels, Tiggelen, Loose, & Cambier, 2007). Approximately two out of three individuals will experience at least one episode of neck pain in their lifetime (Grooten, Mulder, Josephson, Alfredsson, & Wiktorin, 2007). Less than half the computer workers presenting with neck pain were pain free after 1-5 years (Grooten et al., 2007) indicating the severity and chronicity of the problem.

1.4.2 Population affected:

Neck and upper back musculoskeletal symptoms are reported among a diversity of occupations such as dentists, nurses, crane operators (Aas et al., 2011), sewing machine operators and workers in the skilled construction, building sector and agricultural sector (Musculoskeletal disorders in Great Britain 2013). Office and computer workers showed the highest prevalence of neck and upper back musculoskeletal symptoms. The one year prevalence of neck and upper back pain in office workers was reported to be 69% in Belgium, 42% in Thailand, 34% in Finland, 36% in Sweden and 49% in Australia (Aas et al., 2011; Paksaichol, Janwantanakul, & Lawsirirat, 2014). In 1995, the neck and shoulder pain prevalence in South Africa was reported to be 19% (Adebajo, 1995). More recent research on the prevalence of neck and upper back pain among office workers in South Africa was lacking during the literature search.

1.4.3 Financial implications of upper quadrant work related musculoskeletal disorders:

Computer related musculoskeletal claims are increasing, ranging from \$6000 to \$35,000 in the USA (Senhal, 2001). In Que'bec, Canada \$500million dollars was spent in 2000 on compensation due to occupational injuries (Denis, StVincent, Imbeau, Jette, & Nastasia, 2008). A survey conducted in Washington State between 1995-2005, reported that neck, back and upper extremity claims contributed 27% to the total claims compensated (Widarnarko et al., 2011). Upper quadrant work related musculoskeletal disorders are considered to be costly occupational problems and can lead to a significant amount of human suffering and economic burden for the employees, employers, workplaces and society (Nastasia et al., 2014).

1.4.4 Consequences to the employer/ employees:

Musculoskeletal pain has been reported to increase time off work and loss of productivity, which has direct implications on the employer and employee (Hoeben & Louw, 2014). Sick employees either take time off work leading to 'absenteeism' or more commonly; continue to attend work but function at lower levels of performance and productivity, referred to as 'presenteeism' (Linddegard et al., 2005; Tornqvist et al., 2009). Widarnako et al reported that 37% of lost days were due to musculoskeletal disorders, indicating a significant impact of the condition on work output and productivity (Widarnarko et al., 2011).

Upper quadrant work related musculoskeletal disorders are reported to constitute one of the major reasons for long term sick leave (Linddegard et al., 2012). Apart from individual suffering, upper quadrant work related musculoskeletal disorders reduce the quality of life, place a heavy economic burden on the society, lead to long term sick leave, attribute to poorer worker performance and reduce worker productivity (Linddegard et al., 2012). Office workers have been reported to have the highest incidence of neck and upper back disorders (Côté et al., 2008). Office workers are predisposed to developing upper quadrant work related musculoskeletal disorders due to the poorer physical characteristics such as poor postures, reduced upper quadrant muscle strength and endurance (Blatter & Bongers, 2002).

1.4.5 Consequences to the Quality of Life:

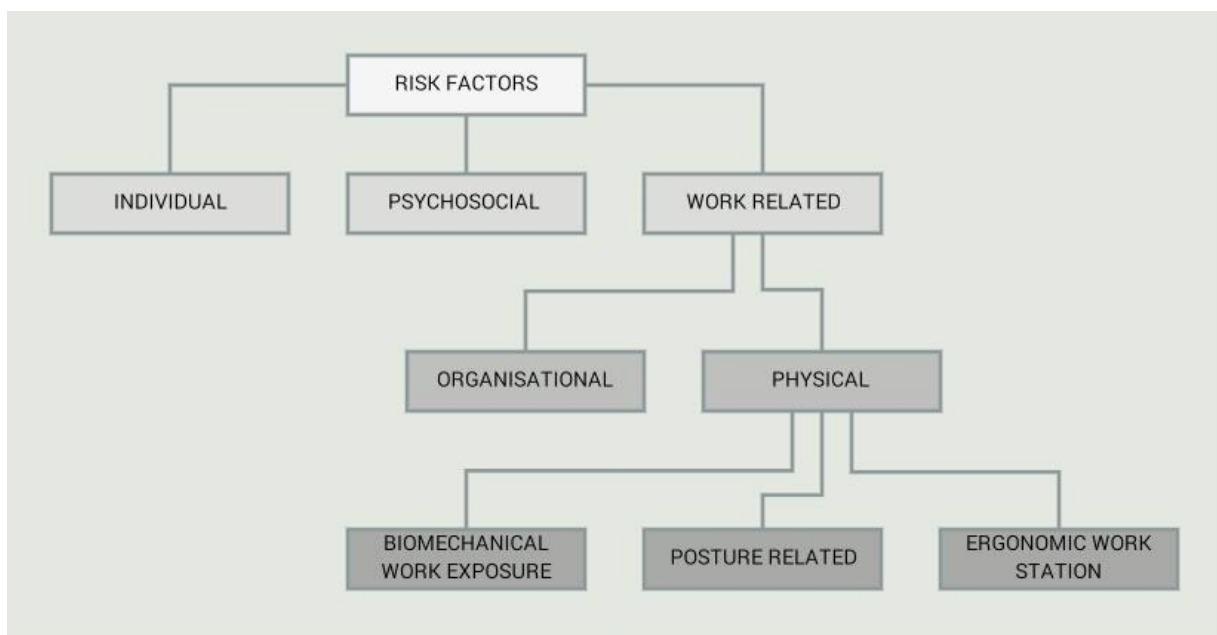
According to the WHO health is a state of complete physical, mental and social well-being and not merely the absence of a disease or infirmity. Upper quadrant work

related musculoskeletal disorders have been reported to create physical impairments and negatively affect the health of office workers (Lucchetti, Oliveira, Mercante, & Peres, 2012). The reduced mental well-being of the office workers increases the likelihood of depression which further increases the risk of poor health and disability (Cho, Jung, Park, Song, & Yu, 2013). Upper quadrant work related musculoskeletal disorders are also reported to reduce the ability of office workers to function effectively within the work environment, affecting the individuals' activities of daily living, which in turn have an impact on their social participation (Manchikanti, Singh, Datta, Cohen, & Hirsch, 2009).

1.5 Risk factors:

Various risk factors of upper quadrant work related musculoskeletal disorders have been identified in the literature, which can broadly be classified into the following sections, each of which will be discussed below:

Figure 1.1: Risk factors of upper quadrant work related musculoskeletal disorders



(Ariens et al., 2001; Cagnie et al., 2007; da Costa & Vieira, 2010; Hush et al., 2006; Johnston, Souvlis, Jimmieson, & Jull, 2008; Johnston, Jimmieson, Jull, & Souvlis, 2009; Lindegard et al., 2012; Waersted, Hanvold, & Veiersted, 2010; Widarnarko et al., 2011)

Several reviews have identified a causal relationship between computer use and upper quadrant work related musculoskeletal disorders (Cagnie et al., 2007; Gerr et

al., 2005; Waersted et al., 2010; Wahlstrom et al., 2004). Neck and upper back pain are most commonly reported among computer users. The risk factors predisposing computer users to neck and upper back pain are multi-factorial (Ariens et al., 2001; Cagnie et al., 2007; Johnston et al., 2009; Johnston et al., 2010; Waersted et al., 2010). These risk factors can be divided into non-modifiable and modifiable risk factors. Non-modifiable risk factors are considered to be the individual risk factors, such as age, gender, previous injury and systemic diseases such as rheumatoid arthritis (Cagnie et al., 2007). Modifiable risk factors include psychosocial factors and work related factors (Cagnie et al., 2007; Johnston et al., 2010; Waersted et al., 2010; Widarnarko et al., 2011).

1.5.1 Individual risk factors:

Some of the individual risk factors for neck and upper back pain identified repeatedly in the literature are gender, age and level of physical activity (Cagnie et al., 2007; da Costa & Vieira, 2010; Hush et al., 2006; Johnston et al., 2008).

1.5.1.1 Female gender:

Women are reported to have an 18% higher prevalence of neck and upper back pain than men (Cagnie et al., 2007). A possible reason for this higher prevalence may be due to the smaller stature of women and their weaker shoulder muscles. Women tend to use higher forces while working on the computer and elicit a greater range of motion of the joints in comparison to men (Cagnie et al., 2007). It is also reported that women demonstrate greater activity in the neck extensors and trapezius muscles compared to men (Johnston et al., 2008; Szeto, Straker, & O'Sullivan, 2005). Women have a tendency to accept work involving lighter physical demands compared to men (Widarnarko et al., 2011) and therefore the majority of computer based occupations are occupied by women. The hormonal fluctuations make women more susceptible to experiencing pain than men. The hormone oestrogen reduces the pain perception in women (Widarnarko et al., 2011). During the menstrual cycle, when oestrogen levels are low, the pain perceived by women is generally higher than during other times of the menstrual cycle (Widarnarko et al., 2011). Women also demonstrate increased sensitivity to pain and have a tendency of reporting symptoms more readily than men (Widarnarko et al., 2011).

1.5.1.2 Age:

Various authors have reported an increased prevalence of neck and upper back pain in different age groups (Cagnie et al., 2007; Gerr, Monteilh, & Marcus, 2006). The age group more frequently affected by computer related neck and upper back pain is between 30 and 65 years of age (Cagnie et al., 2007; Gerr et al., 2006).

Degenerative changes to the musculoskeletal structures are reported to increase as age advances and are one of the reasons of an increased prevalence during the mentioned age bracket (Cagnie et al., 2007).

1.5.1.3 Physical Activity

Individuals who are less physically active have a tendency to experience more musculoskeletal dysfunction (Cagnie et al., 2007; Johnston et al., 2008; Korhonen et al., 2003). It has been reported that physical activity decreases the likelihood of experiencing neck pain (Cagnie et al., 2007). Specific exercises and physical fitness are recognised as an important component of the rehabilitation process when recovering from any musculoskeletal injury (Johnston et al., 2008).

1.5.2 Psychosocial Factors:

There has been extensive research on the impact of psychosocial factors on the pain experienced by office workers (Grooten et al., 2007, Johnston et al., 2010).

According to the 'healthy worker effect' individuals suffering from adverse conditions such as debilitating pain, are likely to leave their jobs (Grooten et al., 2007). Those that continue working experience mild to moderate pain (Grooten et al., 2007). Some of the psychosocial factors described in the literature include mental stress and negative affectivity.

1.5.2.1 Mental stress:

Mental stress has been reported to be a strong contributor to neck and upper back pain (Johnston et al., 2010). Mental stress can be attributed to both personal stress and work related stress. For the sake of this review, further information regarding work-related mental stress has been explored.

A shortage of personnel at work and a subsequent increase in work load are reported to increase the mental stress experienced by the office worker (Cagnie et al., 2007; Johnston et al., 2010). Mental stress also increases when there is increased time pressure and hindrances to work, all of which increase the predisposition to neck and upper back pain (Devereux, Vlachonikolis, & Buckle, 2002).

Other factors increasing mental stress are low control over schedules for work and rest, poor social support from co-workers and managers, lesser career advancement opportunities and lack of opportunities to be involved in the decision making. Mental stress has a tendency to persist over time leading to continuous and low levels of muscle activity which is a potential source of pain (Johnston et al., 2010).

1.5.2.2. Negative affectivity:

Negative affectivity is described as a personality variable that involves the experience of negative emotions and poor self-concept. Negative affectivity has been reported to be a strong predictor of neck and upper back pain (Johnston et al., 2008; Johnston et al., 2009; Lindegard et al., 2005). Negative affectivity in an individual persists over time and is associated with physical and psychological factors (Johnston et al., 2008). It acts as a 'nuisance variable' inflating self-report measures of stressors and strains. It also affects the individual's responses to stressors in the environment, eventually contributing to negative physical and psychological health (Johnston et al., 2008). Therefore an individual with a negative predisposition may always view stressors in the environment with a negative impression compared to those with a positive predisposition.

1.5.3 Work related risk factors:

1.5.3.1 Organisational:

Several studies have revealed that factors related to the organisation influence work-related physical and mental well-being (Cagnie et al., 2007; Driessen et al., 2010; Grooten et al., 2007). Individuals are reported to spend more than a third of their day at work. The demands on their performance, efficiency and effectiveness are constantly on the rise (Driessen et al., 2010; Grooten et al., 2007). It is therefore

necessary that factors influencing the work situation should be given due consideration. Some of the organisational factors that increase neck and upper back pain include the work layout, repetitive and constrained work, daily wages, fewer staff members and long working hours (Driessen et al., 2010; Grooten et al., 2007). There is a rise in the levels of work strain, increasing the physical and mental work load, thereby increasing neck and upper back pain.

It has been suggested that changes at the system level, such as job rotations, modifications to the production system and the recruitment of more staff may help to reduce the influence of organisational risk factors on upper quadrant work related musculoskeletal disorders (Driessen et al., 2010).

1.5.3.2 Physical work factors:

There are a number of physical work factors that contribute to the development of neck and upper back pain.

1.5.3.2.1 Biomechanical work exposure:

Upper quadrant work related musculoskeletal disorders are reported to be influenced by the individual's biomechanics while at work (Grooten et al., 2007). The common factors influencing neck and upper back pain in the general population are manual handling of weights greater than fifty Newton, working for long durations with the hands above the shoulder level, use of vibrating tools, sitting for more than 75% of the time, awkward postures, repetitive work and frequent lifting (da Costa & Vieira, 2010).

The increased prevalence of neck and upper back pain in computer users has been attributed to sitting for more than 75- 95% of the total working time (Ariens et al., 2001; Grooten et al., 2007). Other sources state that sitting for at least five hours a day increases the self-reported neck and upper back pain (Cagnie et al., 2007). Sitting for prolonged periods is accompanied by an increase in the curvature of the spine which in turn increases the pressure on the intervertebral discs, ligaments and muscles (Ariens et al., 2001; Cagnie et al., 2007). All these structures are potential sources of pain therefore increasing pressure on these structures can lead to potential tissue damage (Lindegard et al., 2012).

Two muscles of the neck and upper back namely Splenius Capitis and Splenius Cervicis, serve a stabilising role whereby their static contraction is essential to maintain the stability of the neck and upper back while working in a seated posture (Straker, 2008 c; Straker, Limerick, Pollock, & Maslen, 2009b). The stability of the neck and upper back is compromised if there is any amount of rotation in the neck, or more commonly when flexing the neck e.g. when the visual display terminal is placed below eye level of the user (Cagnie et al., 2007).

There is a positive relation between neck flexion and neck pain (Ariens et al., 2001). Individuals who sit with a minimum of twenty degrees of neck flexion are more prone to neck and upper back pain (Ariens et al., 2001). Furthermore Cagnie et al reported that holding the neck in a forward bent posture increases the prevalence of neck and upper back pain (Cagnie et al., 2007).

1.5.3.2.2 Posture:

Computer work is reported to require the lowest physical activity in the body provided the head, trunk and back are upright (Groenesteijn et al., 2012). Low physical activity combined with increased work load and increased mental concentration during computer work leads to fairly static postures by the computer worker (Aaras, Horgen, Henrik, Ro, & Walsoe, 2001; Cagnie et al., 2007; Groenesteijn et al., 2012; Szeto et al., 2005). The static posture is most pronounced in the neck and upper back region of the office workers (Ariens et al., 2001; Szeto et al., 2005).

The centre of mass of the head on neck is located anterior to the neck. When the trunk is vertical, cervical extensor muscle activity is necessary to maintain the static equilibrium of the head and neck complex, and to help overcome the gravitational pull (Straker, Pollock, Limerick, Skoss, & Coleman, 2008 a ; Straker et al., 2008 b; Straker, Limerick, Skoss et al., 2008 c). During active flexion of the neck, movement occurs at the atlanto-occipital, mid and lower cervical joints. As flexion increases, the horizontal distance of the centre of mass of the head and neck is combined, and the axis of rotation in the vertebral column also increases (Straker et al., 2008 b; Straker, Limerick, Skoss et al., 2008 c). To balance out the flexion moment and to enable a controlled movement an increase in activity of the neck extensor muscles is required (Straker, Pollock, Limerick, Skoss, & Coleman, 2008 a; Szeto et al., 2005).

The muscles responsible for extension at the neck are as follows: the Sub-occipital muscles elicit extension at the atlanto occipital joint; the Semispinalis Capitis and -Cervicus elicit extension at the atlanto-occipital joint and the mid cervical region; and the Iliocostalis Cervicus elicits extension at the mid and lower cervical region (Straker et al., 2008 b; Szeto et al., 2005). The Sternocleidomastoid muscle is considered to be a weak extensor of the atlanto-occipital joint. The Upper Trapezius (UT) is a large, multidirectional muscle with compound actions such as scapular and head on neck stabilisation (Straker et al., 2008 b).

To enhance the stability of the neck, these muscles of the neck must balance the external forces that the neck is subjected to. The stability of the neck is increased by the co-contraction of the neck muscles, which prevents the intervertebral buckling of the cervical spine thus maintaining the stability of the head and neck complex (Straker et al., 2008 b; Szeto et al., 2005).

Computer users have a tendency of developing a forward head posture which is a combination of flexion at the cervical joints and extension at the upper cervical spine, in particular the atlanto-occipital joint (Limerick, Plooy, Fraser, & Ankrum, 1999). It is proposed that muscles such as the Sub-occipital muscles, Splenius Capitis and Splenius Cervicus, which bring about extension of the upper cervical spine will shorten due to the increase in extension of the head on neck. There is a decrease in the average fibre length of these mentioned muscles. The Sub-occipital muscles are relatively short, and with further shortening due to sustained positioning over time, the tension generating capacity of the muscles is reduced (Limerick et al., 1999).

A study conducted by Szeto et al (2005), found that subjects complaining of neck symptoms had an increase in forward head posture compared to the asymptomatic subjects. The increase in forward head posture leads to the development of fixed postural habits and in turn contributes to different muscle control strategies that develop concurrently (Szeto et al., 2005). It has been reported that adopting altered postures at the neck and upper back region for prolonged periods of time is likely to lead to the development of discomfort in the neck and upper back (Ankrum & Nemeth, 1995). The increase in forward head posture results in the increase in activity of the postural stabilising muscles. This increased muscle forces leads to higher compressive forces at the articulations of the cervical spine resulting in

greater chances of developing upper quadrant work related musculoskeletal disorders (WRMSD) (Szeto et al., 2005).

The visual system is also reported to influence the discomfort caused by the gaze angles (Hochanadel, 1995; Limerick et al., 1999; Szeto et al., 2005). Postures adopted during computer use could be as a result of reaching a compromise between the visual discomfort (due to the gaze angle) and musculoskeletal discomfort (caused by cervical flexion and upper cervical extension) (Szeto et al., 2005).

1.5.3.2.3 Ergonomic work station risk factors:

Johnston et al found no association between self-reported ergonomic factors and the prevalence of neck and upper back pain (Johnston et al., 2009). In contrast individuals who report their workstation as uncomfortable are more prone to neck and upper back pain (Johnston et al., 2009; Johnston et al., 2010).

Some of the common ergonomic factors reported to influence the neck and upper back pain are the mouse, keyboard, computer screen/ visual display terminal (VDT), and the workstation chair (Johnston et al., 2010; Waersted et al., 2010).

The lay-out of the computer work station influences neck and upper back pain. The visual display terminal (VDT), the type and use of the input device and the force required while operating the keyboard/ input device increases neck and upper back pain (Johnston et al., 2010). Using the mouse for more than six hours and working continuously on the computer for more than two hours daily is also reported to increase neck and upper back pain (Johnston et al., 2008; Johnston et al., 2009; Johnston et al., 2010).

Andersen et al oppose this and state that prolonged computer mouse use is not associated with chronic pain in the neck and shoulder (Andersen et al., 2008). They found no relationship between computer and mouse use and chronic neck and upper back pain. They found that acute neck and upper back pain can be influenced by the mouse use, but does not contribute to chronic pain (Andersen et al., 2008). There is insufficient evidence to support a direct relationship of mouse use to neck and upper back conditions. Instead the mouse use is seen to influence the hand and wrist

conditions (Andersen et al., 2008). A systematic review conducted by Waersted et al also report that there is limited evidence of a relationship between the time spent on the computer mouse and neck and upper back pain (Waersted et al., 2010).

Gerr et al report that the vertical placement of the keyboard can influence neck and upper back pain, especially if the keyboard placement is too high (Gerr et al., 2004). They found that the keyboard height and the head rotation affect neck and upper back pain and stiffness (Gerr et al., 2004). In 2006, Gerr et al reported that a combination of processes, such as placing the keyboard below the elbow, limiting the head rotation, and resting the arms, may result in reduction of neck/ shoulder outcomes. With respect to the keyboard, they propose changes to reduce ulnar deviation and keyboard thickness which would result in reduction in hand and arm conditions and less relation to the neck and upper back (Gerr et al., 2006). They link keyboard use to hand and arm conditions as opposed to neck and upper back conditions. A systematic review conducted by Waersted et al reports that there is insufficient evidence between the time spent on the keyboard and the prevalence of neck and upper back pain (Waersted et al., 2010).

Modification of the workspace is not always economically viable, and can be limited due to physical constraints (van Niekerk, Louw, & Hillier, 2012). Therefore modification of the chair can offer the most pragmatic solution in workstation adjustments.

The chair used at the workstation has been studied in great depth and the features that can be altered on some chairs are so vast that it has been difficult to find conclusive recommendations regarding the type of and use of chairs (Johnston et al., 2008). Cagnie et al (2007) support the use of dynamic sitting/ standing chairs as they promote more variation in the individual's posture and comfort (Cagnie et al., 2007).

The available literature on the use of chairs to help reduce neck and upper back pain is heterogeneous (van Niekerk et al., 2012). Chair modifications have been reported to be beneficial in reducing the severity, intensity and frequency of neck and upper back pain (Robertson, Benjamin, DeRango, & Rooney, 2009; Amick et al., 2012). The chair design can potentially influence the viewing angle of the computer user as

well as the viewing distance, therefore influencing musculoskeletal health and ocular symptoms (Amick et al., 2012). The chair can help attain the user's optimal viewing angle; which is considered to balance musculoskeletal postures and eye comfort (Amick et al., 2012). An adjustable chair minimizes the changes in the head location, allowing the viewer to find a comfortable viewing angle, without other adjustments.

Anthropometry is the most important factor to consider in deriving chair dimensions and designing comfortable chairs for adults (Straker, Maslen, Limerick, Johnson, & Dennerlein, 2010; Thariq et al., 2010). Thariq et al recommend the use of workstations with adjustable seats, to fit the varying anthropometrics and postural differences of office workers (Thariq et al., 2010). A mismatch between the seat elbow height and desk height is significantly related to neck and shoulder pain (Thariq et al., 2010). The most common parameter of the chair that is adjusted is the seat height (Thariq et al., 2010; van Niekerk et al., 2012).

EMG studies of adjustable seat and back height report reduced muscle activities of the neck, upper back, shoulder, back as well as the intervertebral disc pressure (Thariq et al., 2010; van Niekerk et al., 2012). Once the muscle activity reduces, and the intervertebral disc pressure decreases, there is believed to be a reduction in the loading of the spine, which in turn helps to reduce the pain experienced (Straker et al., 2008a).

A large study conducted by Ariens et al reported that neck flexion is directly related to neck and upper back pain (Ariens et al., 2001). The study concluded that a working posture with a minimum of 20degrees of neck flexion for more than 60% of the working time increased the chance of developing neck and upper back pain. Neck rotation, however does not show a similar trend (Ariens et al., 2001). Rotation of more than 45degrees did not influence the response rate of neck and upper back pain (Ariens et al., 2001). Similar results were found by Straker et al in 2008a, 2009b and Szeto et al in 2005, all reinforcing the influence of neck flexion on neck and upper back symptoms (Straker et al., 2008a; Straker, Limerick, Skoss et al., 2008b; Straker, Limerick, Pollock, & Maslen, 2009a; Straker, Limerick, Pollock, & Maslen, 2009b; Szeto et al., 2005).

The sagittal movements of flexion and extension of the neck are aimed at adjusting the viewing angle while working on the VDT (Limerick et al., 1999). The viewing angle can be adjusted by changing either the neck position, or by moving the trunk or by moving the eyes only (Limerick et al., 1999). If the neck movements are considered independently, it has been found that if the top of the screen is positioned level with the eye, the posture of the head and neck will be more upright (Straker et al., 2009a; Straker et al., 2009b). This posture has been reported to reduce the Cervical Erector Spinae activity, but could be more stressful for the visual system (Straker et al., 2009a; Straker et al., 2009b). Lower display placements are associated with greater head and neck flexion, which are reported to be more stressful on the neck and upper back muscles (Straker et al., 2008a; Straker et al., 2009b).

Downward gazes involving mid-displays have been suggested to be better for the visual system and the musculoskeletal system (Ankrum & Nemeth, 1995). A mid-display increases the gravitational moment, thus increasing the extensor torque required to maintain this position (Ankrum & Nemeth, 1995; Sommerich, Joines, & Psihogios, 2001). Various authors report an increase in the Cervical Erector Spinae muscle activity with mid-displays (Ankrum & Nemeth, 1995; Sommerich et al., 2001; Straker et al., 2008a; Straker et al., 2008b; Straker et al., 2008c). There is an associated increase in the Upper Trapezius activity with mid-display (Aaras et al., 2001; Sommerich et al., 2001). This finding is however contradicted by Briggs et al, who report a decline in the activity of the Upper Trapezius with a lower VDT position (Briggs, Straker, & Grieg, 2004). Fostervold et al found no reduction in the Trapezius activity for displays that ranged from 15- 30 degrees below horizontal (Fostervold et al., 2006). Limerick et al found that a mid-display did not change the position of the neck with respect to the trunk, but it does reduce the extension of the atlanto-occipital joint and the upper cervical region (Limerick et al., 1999).

On the other hand, the evidence also supports the use of eye level displays which are referred to as high displays in the literature (Straker et al., 2009a; Straker et al., 2009b). Eye level displays are meant to be associated with a lower mean head on neck flexion and scapular elevation, but create more extension at the upper cervical spine. Various researchers have shown a reduction in cervical extensor muscle

activity (Straker et al., 2008b; Straker et al., 2009a; Straker et al., 2009b). It is reported that the extension of the upper cervical spine is associated with a more neutral lower cervical spine; leading to a reduction in the extensor torque in the Cervical Erector Spinae muscles. There is little impact that has been reported on the Upper Trapezius with this high display position (Straker et al., 2008a; Straker, Limerick, Skoss et al., 2008b).

To summarise, the sagittal neck movements appear to influence neck and upper back pain: especially chronic neck and upper back pain. The rotational movements do not influence this pain. The sagittal neck movements are influenced by the head on neck position and the neck flexion angle. Both of these can be affected by the vertical parameters. Two factors influencing the vertical alignment are the chair position and the screen (VDT) position, the alignment of both can affect the sagittal neck movements, and in turn predispose an individual to neck and upper back pain.

1.6 Pathophysiology:

There are a number of pathophysiological contributors to computer-related neck and upper back pain (Cagnie et al., 2007). The static postures assumed during computer work lead to continual recruitment of specific motor units for a prolonged period of time leading to localised muscle fatigue and injury (Straker, Limerick, Pollock, & Maslen, 2009b). The “Cinderella Hypothesis” is seen as the most influential hypothesis in explaining tissue damage related to computer use (Cagnie et al., 2007). This hypothesis states that the selective and sustained activation of type 1 motor units due to low intensity sustained tasks, leads to calcium accumulation in these active motor units. Due to the sustained postures, there is a reduction in the local blood supply, therefore reduced metabolite removal from the muscle compartments creating homeostatic disturbances (Cagnie et al., 2007). In addition, there is nociceptive sensitization which occurs as a result of intramuscular shearing forces. In the long term, subjects suffering from chronic neck and upper back pain also present with reduced sensitivity to temperature changes (Johnston et al., 2008).

1.7: Outcome measures:

Common outcome measures used to assess individuals with neck and upper back pain include the Neck Disability Index, Job Content Questionnaire, Numeric Pain Scale, McGill Pain Questionnaire and the Visual Analogue Scale (VAS).

The level of disability reported in individuals with neck and upper back pain is reported to be low (Grooten et al., 2007). The benefit of using the Neck Disability Index on assessing changes in the neck and upper back pain is therefore questionable. The Job Content Questionnaire is used to identify work-related psychosocial factors (Paksaichol, A., Janwantanakul, P., & Lawsirirat, C., 2014). In comparison to the other tools such as the McGill Pain Questionnaire and the Numeric Pain Scale, the validity of the VAS is reported to be higher (Ferraz et al., 1990).

The Visual Analogue Scale (VAS) is a self-report instrument, which has been used repeatedly to measure the subjective pain levels among office workers (Gerr et al., 2005; Mekhora, Liston, Nanthavanij, & Cole, 2000). According to Reips and Funke, the VAS is a simple instrument to use; it is more exact and requires less explanation (Reips & Funke, 2008). The reliability and validity for the VAS have been established (Gajasinghe, Wijayaratna, & Abayadeera, 2010; Hawker, Mian, Kendzerska, & French, 2011). The validity of the VAS has been demonstrated with a correlation coefficient of 0.95. Test re-test reliability was established at 0.71-0.99 (Ferraz et al., 1990). The minimal clinically important difference (MCID) has been shown for chronic conditions is between 11 and 13.7 mm out of one hundred (Hawker et al., 2011). It can thus be a useful measure in evaluating the effect of an intervention on the neck and upper back pain.

Comfort is defined as a pleasant state or a relaxed feeling of a human being in reaction to her/ his environment (Vink, 2012). Comfort is influenced by various factors such as the emotions, expectations of the subject, the physical features and aesthetic design of the work station, as well as the physical environment, task and the psychosocial factors of the work (Vink, 2012). Comfort is considered a better scale to measure forces that require a lower maximum voluntary contraction (MVC) which is often the case with computer users (Vink, 2012). A systematic review by De

Looze et al noted that comfort and discomfort have been used as separate entities with different underlying factors, or have been interpreted as two extremes of a continuum (DeLooze, Lottie, Kuijt, & Dieen, 2003). Comfort and discomfort have also been used interchangeably (DeLooze et al., 2003; Kong, Kim, Lee, & Jung, 2012). Kong et al found that the continuum evaluation is more sensitive to the changes in comfort and discomfort (Kong et al., 2012). Thus the continuum evaluation of comfort at one end, and discomfort at the other end could be useful in assessing the changes caused by an intervention.

Wahlstrom et al (2004) suggest that comfort could be used as an important outcome measure to identify the risk of developing chronic musculoskeletal disorders. Previous studies have used a VAS or questionnaires to measure comfort (Gerr et al., 2005; Lindegard et al., 2012). However, as comfort is arguably a less often investigated construct compared to outcomes such as pain, further research may be required to establish standardised methods to measure comfort.

The benefits of assessing the participant's pain and comfort levels could prove useful to assess the differences, good or bad, elicited by an ergonomic intervention.

1.8 Interventions

1.8.1 Participatory Ergonomics:

Participatory ergonomic techniques (PET) are aimed at involving the individual in the planning and controlling of the work activities, therefore it may influence the intervention and outcomes to achieve the desirable goals (Hignett, Wilson, & Morris, 2005). The most successful strategies of PET are to involve changes in the work organisation, work practices and design of the work environment (Hignett et al., 2005) (Appendix 1).

Korkmaz and Sommerich (2009) reported that PET was more valuable in learning about healthy computing skills, as opposed to subjects receiving leaflets on correct ergonomics. Individual participation in ergonomic modification seems to be a useful intervention as study participants are involved in the decision making process which may lead to enhanced awareness about the 'good' and 'bad' ergonomic habits (Korkmaz & Sommerich, 2009).

1.8.2 Exercise:

Most international guidelines available on exercise are aimed at preventing general musculoskeletal disorders (Andersen et al., 2010). Meta-analyses show that strength training three times a week for people not experiencing musculoskeletal symptoms is important to show sufficient strength gains in the muscles of untrained individuals ((Driessen et al., 2010; Grooten et al., 2007). With individuals experiencing pain, the literature indicates that specific strengthening of the neck and shoulder region seems to be the most favourable solution (Andersen et al., 2010). The duration and frequency of exercise to reduce neck and upper back pain has not been reported.

It has been reported that there was no statistical difference in moderate to high intensity physical exercises in comparison to those receiving no intervention (Bernaards et al., 2007). In contrast another study reports improvements in the pain intensity in the intervention group undergoing exercises at regular intervals (Van den Heuvel et al., 2003). Therefore there are mixed results on the benefits of exercises to reduce neck and upper back pain (Appendix 1).

1.8.3 Pause breaks

A 'pause' has been defined as the minimal time between two computer events, and that there is a linear relationship between pause definition and work duration (Richter, Slijper, Over, & Frens, 2008). The use of pause 'gymnastics' has been widely used in studies, but various other interventions was included as well, such as relaxation techniques, ergonomics and body function education (Kamwendo & Linton, 1991; Ketola et al., 2002; Van den Heuvel et al., 2003). Kamwendo and Linton (1991) found no significant difference between the intervention and control groups. Ketola et al and Van den Heuvel et al, reported improvements with respect to neck and upper back pain, but the direct contribution of the pause breaks alone is not clear (Ketola et al., 2002; Van den Heuvel et al., 2003). No inference can be made on the use of pause breaks alone as a management strategy to reduce neck and upper back symptoms.

1.8.4 Myofeedback training

Voerman et al investigated the effect of myofeedback training based on the Cinderella Hypothesis, whereby sustained contraction of the muscles due to stationary positions leads to musculoskeletal discomfort (Voerman et al., 2008). The

feedback was aimed at making the participants aware of insufficient relaxation of the Upper Trapezius (UT); therefore improving the time spent in relaxing of this muscle, with the aim that there would be a reduction in musculoskeletal complaints. These authors found no significant difference in the pain intensity between the intervention group that underwent myofeedback training and the control group that underwent workstation modification (Voerman et al., 2008).

1.8.5 Workstation layouts:

A survey conducted to assess the workstation layout and working postures revealed that at least 20-60% of the office worker's furniture was not optimal for the user's height (Toomingas & Gavhed, 2008). The lack of congruency between the user and the workstation leads to awkward seated postures, which in turn leads to the development of pain (Cagnie et al., 2007; Toomingas & Gavhed, 2008; Waersted et al., 2010). The postures adopted by the subjects who sit for prolonged periods vary, ranging from extended/flexed neck postures, craned neck postures, rotated neck postures, and some adopting normal postures (Toomingas & Gavhed, 2008).

A good working posture can only be enabled if all parts of the office equipment are designed and fit together to form an integrated, functional and comfortable workstation unit. Good individual working technique may compensate for some negative effects of the maladjusted furniture (Toomingas & Gavhed, 2008). However, even if adjustable furniture is provided to the user, it does not guarantee better working postures, unless the user is educated on how to use the equipment. Those that indicated dissatisfaction with their workstation layout complained mostly of the input devices, the desk and the chairs (Toomingas & Gavhed, 2008) (Appendix 1).

Some of the suggestions for workstation modifications available in the literature are as follows:

1.8.5.1 Chair interventions:

Various researchers recommend that the workstation should be positioned in such a way that the shoulders of the office worker are in a relaxed position (Thariq, Munasinghe, & Abeysekara, 2010; Toomingas & Gavhed, 2008). If the work surface is too low, the user will have to bend too far forward. If the workstation is too high, the user will be forced to raise the shoulders, therefore increasing the strain on the

neck, upper back and lumbar spine (Thariq et al., 2010; Toomingas & Gavhed, 2008). Optimal height adjustments of the workstation lead to less frequent neck and upper back pain (Thariq et al., 2010; Toomingas & Gavhed, 2008).

Annetts et al (2012) compared four different chairs and the effects thereof on spinal angles on healthy subjects. All the chairs examined reduced the posterior pelvic tilt; therefore affecting the lumbar spine, which contributes indirectly to the neck position. Ideal lumbo-pelvic posture does not however always enhance good cervical spine posture (Annetts et al., 2012). To improve the cervical spinal angles, they recommended the use of a 'Swopper Chair' which allows rotational movement, necessary during office work (Annetts et al., 2012). This 'Swopper chair' was described as one lacking a back rest, which helps reducing the extremes of postural changes, and aids in reducing the forward head posture. Majority of individuals performing computer work opt for adjustable seats with a back rest (Cagnie et al., 2007).

Groenesteijn et al report that VDT use leads to a more forward inclination in comparison to reading, which supports a more backward inclination (Groenesteijn et al., 2012). Forward inclination has been repeatedly associated with increasing neck and upper back symptoms. Groenesteijn et al found that the chair type does not enhance lower muscle activations and therefore strongly recommend **other interventions** in addition to chair modifications to help reduce the musculoskeletal symptoms of office workers (Groenesteijn et al., 2012).

1.8.5.2 Visual display terminal (VDT):

Extensive research has been done on the effects of the visual display terminal (VDT) on upper quadrant WRMSD's. The European Union implemented a council directive 90/270/EEC (1990) which is a compulsory directive for all European Union members (Zunjic, Milanovic, Milanovic, Misita, & Lukic, 2012). It is a minimum health and safety requirement for all work involving a display screen offering guidance on using the VDT. All employers are obliged to assess and improve the workstation of the VDT using this directive (Zunjic et al., 2012). This directive does not however offer a tool to assess the VDT.

In the process of developing tools to assess the VDT, Zunjig et al assessed 140 different questions regarding the VDT and considered many factors such as mental stress, noise, lighting, temperature, humidity, software, other input devices and glare/reflection (Zunjic et al., 2012). Their questionnaires were aimed at identifying non-ergonomic chair placement, improper VDT placement, improper postures, and thus finding ways to implement neutral postures (Zunjic et al., 2012). They concluded that majority of the users do not know what ergonomics is, nor are they aware that the VDT workplaces should meet certain health and safety requirements. The correct positioning of the VDT can be achieved by a height- adjustable work station (Zunjic et al., 2012). There was however no conclusion on the best position of the neck and upper back while working on the computer.

In 2005 Gerr et al examined the differences in VDT height placements (Gerr et al., 2005). According to the OSHA (Occupational Safety and Health Administration), NIOSH (National Institute of Occupational Safety and Health) and private industry guidelines Gerr et al used, they assessed the benefits of placing the eye level at the top of the monitor screen (Gerr et al., 2005). They found no significant difference in their results; therefore neither the high displays nor the mid-displays were advantageous over the other (Gerr et al., 2005).

Straker et al also report that there is not much difference on the Cervical Erector Spinae and Upper Trapezius muscle activity when using a high display or a mid-display (Straker et al., 2008a). A mid-display is preferred because of reduced oculomotor and musculoskeletal symptoms. The neutral zone of the cervical spine is reported to be between 0-15 degrees of flexion (Straker et al, 2008a; Straker et al., 2008b; Straker et al., 2008c).

There is very little data on Erector Spinae activity with ultra-high displays, and with very low displays. The ultra-high displays could lead to an increase in the strain on the Sub Capital muscles (Straker et al, 2008a; Straker et al., 2008b; Straker et al., 2008c; Straker et al., 2009b). Neither the ultra- high displays nor the very low displays have been researched extensively.

It has been recommended that workstations should allow display height adjustment to enable a downward viewing angle (Limerick et al., 1999; Straker et al., 2008c).

However there was no specific angle that is particularly advantageous to the CES and UT muscle activity level (Limerick et al., 1999). Straker et al noted similar responses to display heights in adults and in children, and recommended that children start with the top of the display sitting at eye level and adjust it lower if required for comfort (Straker et al., 2009a; Straker et al., 2009b).

It can be summarised that ultra-high displays and ultra-low displays have not been supported by the literature. The eye level displays and slightly below eye level displays are recommended, but neither one appears to be more superior to the other.

1.8.5.5 Combined interventions:

In 1995, Hochanadel performed a large study to assess the effect of adjusting specific workstation heights based on the individual's anthropometry. The changes were made by the subjects themselves, based on a computer programme, named PC SAFE- Personal Computer-Self Adjusting Functional Ergonomics. This program adjusted the workstation parameters based on the gender and height of the participant. The two most common mismatches between the individual's habitual workstation and the calculated parameters by the program were the chair height, followed by the VDT height (Hochanadel, 1995).

Hochanadel recommended placing the participant's shoulders in a relaxed position with the upper arms in line with the trunk thereby reducing the reach and the static loading of the neck and shoulder muscles. The VDT was placed in line with the eye level (high display) to minimise neck extension or twisting. The feet were supported with the knees slightly higher than the hips to reduce pressure on the posterior thigh. The elbows were placed at keyboard height, with the forearms parallel to the floor to ensure a neutral wrist position (Hochanadel, 1995).

After correcting the mismatch, eighty percent of the subjects reported improvement in their symptoms, as well as improved efficiency and comfort, while 90% reported increased knowledge of proper work station configuration. The guidelines proposed by Hochanadel were very simple and practical, using the already existing furniture. The desk height was chosen as a fixed reference point, and the height of the chair and screen was adjusted according to the recommendations. But their research also

involved adjusting the VDT glare, the lighting source, mechanical problems such as inadequate leg room, and sharp edges of the tables. Therefore their recommendations were very heterogeneous, as are most of the available guidelines in the literature (Hochanadel, 1995).

1.9 Significance of this study:

There are a wide range of ergonomic interventions described in the literature to manage upper quadrant work related musculoskeletal disorders (UQWRMSDs) (Driessen et al., 2010; Groenesteijn et al., 2012; Waersted et al., 2010, Appendix 1). Self-report surveys conducted to identify the contributing factors of neck and upper back pain and sitting comfort repeatedly refer to the workstation set up (Zunjic et al., 2012). Most reviews discuss the benefits of ergonomic interventions and workstation adjustments (Aas et al., 2011; Boocock et al., 2007; Driessen et al., 2010; Waersted et al., 2010; Appendix 1). Certain government directives issued make workstation adjustments compulsory in the office set ups (Zunjic et al., 2012).

Numerous guidelines are used to alter the workstation (Gerr et al., 2005; Hochanadel, 1995). Ergonomists are often recruited to make the alterations to the workstation and often large sums of money are spend in adjusting the computer user's workstation. Heterogeneous adjustments have been described in the literature, ranging from adjustments of the chair, mouse, keyboards, lighting, desks, footrests, humidity, ventilation, to mention but a few (Aas et al., 2011; Boocock et al., 2007; Driessen et al., 2010; Waersted et al., 2010; Appendix 1).

The multifaceted ergonomic workstation adjustments make it difficult to assess the effects of a specific intervention. It may not always be economically viable to adjust numerous items of the workstation (van Niekerk et al., 2012). Various authors recommend that ergonomic interventions should be clearly defined so that the results of the studies are useful clinically (Aas et al., 2011; Driessen et al., 2010; Silverstein & Clark, 2004). The workstation adjustments made are aimed at reducing the modifiable risk factors and help alleviate or prevent the upper quadrant work related musculoskeletal disorders.

A simple adjustment of the chair and VDT height, without additional advice has not been researched based on an extensive literature review. This is a simple, practical,

cost effective intervention which may enable the office worker to make adjustments independently without seeking advice from ergonomists, or follow guidelines that may not necessarily suit the user's anthropometrics.

1.10 Study aim:

The aim of this study was to identify simple parameters that could contribute to reduction of the neck and upper back pain, and improve the sitting comfort of an office worker. The vertical parameters of the chair and VDT, thought to significantly contribute to the gaze angle of the office worker while working on the computer, were investigated.

CHAPTER 2: Effect of a chair and computer screen height adjustment on the neck and upper back musculoskeletal symptoms in an office worker

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2.1 Abstract

Aims: To assess the effect of a chair and computer screen height adjustment on the neck and upper back musculoskeletal symptoms in an office worker.

Methods: An N=1 study was conducted using the ABC design. Ethics approval was obtained for the study and the participant provided informed written consent. The participant was assessed over three four week phases as she performed her habitual computer work. The outcome measures assessed during the three phases were the pain intensity and perceived sitting comfort. The three phases were named the baseline, intervention and wash-out phases. During the baseline phase, the outcome measures were obtained at the participant's habitual work station. The intervention phase involved a vertical adjustment of the chair and computer screen height. The wash-out phase allowed the participant to adjust the chair and computer screen height to their choice. A follow-up interview was conducted with the participant three months after completion of the study. The mean values and the ranges of the pain intensity and perceived comfort were obtained and compared. The data collected was captured on a Microsoft Excel 2010 spread sheet, where after the data was tabulated and presented graphically.

Results: The mean pain intensity of the participant increased slightly during the intervention phase in comparison to the baseline phase, but remained stable during the wash-out phase. The mean perceived sitting comfort deteriorated initially during the intervention phase, but improved later during the intervention phase and showed greater improvement during the wash out phase. The perceived sitting comfort showed more improvement than the pain intensity during the washout phase. Both the pain intensity and perceived sitting comfort showed improvement at the three months follow up assessment, post completion of the study.

Conclusion: The vertical height adjustment of the chair and the VDT did not improve the participant's pain intensity and perceived sitting comfort when compared to the participant's habitual workstation parameters. The findings do not favour the horizontal viewing angle. The findings of this study however support the use of 'slightly below horizontal' viewing angle as being conducive to reduce the pain intensity and improve the sitting comfort of an office worker.

2.2 Introduction

Office based jobs gained vast popularity over the last decade (Groenesteijn et al., 2012). Computer use during office work has amplified to meet the high work demands, productivity demands, time deadlines and increased work output that is required (Hoeben & Louw, 2014; Korhonen et al., 2003; Senhal, 2001). The increase in frequency, intensity and popularity of computer use is directly associated with the increase in the incidence of upper quadrant work related musculoskeletal disorders (Ariens et al., 2001; Cagnie et al., 2007; Hoeben & Louw, 2014; Korhonen et al., 2003; Senhal, 2001).

The upper quadrant work related musculoskeletal disorders (WRMSD's) manifests as pain, discomfort, muscle tension and disability. The neck and upper back are most commonly affected (Hakala et al., 2010; Wahlstrom et al., 2004). Computer users tend to adopt more sedentary postures, as their work requires higher cognitive processing and mental attention (Johnston et al., 2010). The predominantly seated postures adopted while working on computers are strongly associated with neck and upper back pain (Blatter & Bongers, 2002).

Neck and upper back pain is considered a costly occupational problem, leading to a significant amount of human suffering and a large economic burden for the employers, workplaces, workers and society (Nastasia et al., 2014). The one year prevalence of neck and upper back pain in office workers was reported to be 69% in Belgium, 42% in Thailand, 34% in Finland, 36% in Sweden and 49% in Australia (Paksaichol et al., 2014). In 1995, the neck and upper back pain prevalence in South Africa was reported to be 19% (Adebajo, 1995).

The chronicity of the neck and upper back pain is rising. Two out of three individuals will have at least one episode of neck pain, and only half will be symptom free after 1-5 years (Grooten et al., 2007). It is therefore essential to manage neck and upper back symptoms before the symptoms become persistent. Persistent neck and upper back pain has been reported to create physical impairments and negatively affect the health of office workers (Lucchetti et al., 2012). The reduced mental well-being of the office workers tremendously increases the likelihood of depression which increases the risk of disability (Cho et al., 2013). The individual's negative health reduces the

working ability of office workers to function effectively within the work environment affecting the individuals' activities of daily living, which in turn have an impact on social participation (Manchikanti et al., 2009).

A study conducted by Szeto et al found that subjects complaining of neck and upper back symptoms had increased forward head posture compared to the asymptomatic subjects (Szeto et al., 2005). An increased forward head posture leads to the development of fixed postural habits and altered muscle control strategies (Szeto et al., 2005). Ankrum and Nemeth suggest that adopting postures at the neck and upper back region for prolonged periods of time could lead to the development of neck and upper back discomfort (Ankrum & Nemeth, 1995).

An assessment of the workstation layout and work postures by Toomingas et al, revealed that at least 20-60% of the furniture was not optimal for the user's height (Toomingas & Gavhed, 2008). The workstation furniture and equipment, in particular the desk, the chair, the computer and the input devices were primarily problematic (Toomingas & Gavhed, 2008). This lack of congruency between the user and the workstation leads to awkward seated postures and ensuing pain and discomfort (Cagnie et al., 2007; Toomingas & Gavhed, 2008; Waersted et al., 2010).

Ergonomic interventions are reported to have a positive effect on the neck and upper back pain of the computer users (Driessen et al., 2010; Straker et al., 2010; Toomingas & Gavhed, 2008; Waersted et al., 2010). The most frequent intervention is modification of the workstation (Aas et al., 2011; Waersted et al., 2010). It has been reported that if the work surface is too low, it may encourage a flexed posture and elevated shoulders. This posture could place strain on the neck, upper back and lumbar spine (Thariq et al., 2010; Toomingas & Gavhed, 2008). Optimal height adjustments of the workstation could reduce the development of neck and upper back pain (Toomingas & Gavhed, 2008).

Modification of the workspace is not always economically viable and can be limited due to physical constraints (van Niekerk et al., 2012). The chair and VDT height is the most common workstation adjustment among office workers (Thariq et al., 2010). This simple height adjustment of the chair and the VDT may assist in obtaining the optimal viewing angle to facilitate good posture, comfort and alleviation of neck and

upper back musculoskeletal symptoms (Ariens et al., 2001; Cagnie et al., 2007; Straker et al., 2010; Szeto et al., 2005).

There is a lack of consensus on the optimal height of the VDT. Gerr et al found no benefits of using the VDT at the horizontal level, which has been referred to as a 'high display' or an 'eye level' display in the literature (Gerr et al., 2005). High displays and mid-displays (slightly below horizontal) are often recommended, but neither one has been reported to be more superior to the other (Gerr et al., 2005). The literature places a lot of importance on the viewing angle of the VDT, as this determines the posture the computer user adopts. Straker et al describe the neutral zone of the neck to be between 0-15degrees of flexion (Straker et al., 2008b). The most important determinants for an optimal viewing angle are the chair and VDT height.

There has been no investigation to assess the effect of a vertical adjustment of the chair and VDT height on the neck and upper back musculoskeletal symptoms in an office worker. This study thus aims to assess whether vertical height adjustment of the chair and the VDT has an effect on neck and upper back pain and perceived sitting comfort.

2.3 Methodology

2.3.1 Ethical considerations:

Ethics approval was obtained from the Health Research Ethics Committee at Stellenbosch University (Protocol number: S13/10/215, Appendix 3). Informed written consent was obtained from the participant (Appendix 4). All forms containing the participant's confidential information were stored in a safe facility.

2.3.2 Study design:

A single subject design N=1, Type A-B-C, was conducted over a three month period, with each phase lasting four weeks. A follow up questionnaire and an exit interview was completed three months after the completion of the study.

2.3.3 Study phases:

Phase A: 'The Baseline Phase'

This phase lasted four weeks to obtain the baseline outcome measures. No changes were made to the 'habitual' work station.

Phase B: 'The Intervention Phase'

The intervention was implemented by changing the habitual chair seat height and habitual VDT height to the adjusted chair seat height and adjusted VDT height that was calculated. This phase lasted four weeks. No other intervention or advice was provided.

Phase C: 'The Wash out Phase'

This phase lasted four weeks and the participant was permitted to adjust the workstation parameters to a setting of her choice, or to leave the setting should she chose to do so. At the end of this phase, the chair seat height and the VDT height were measured to ascertain if any changes were made to the workstation by the participant independently.

2.3.4 Study procedure:

- **Preliminary procedures:**

An eligible participant was recruited at a large private hospital in the southern suburbs of Cape Town. An email (Appendix 5) was sent to this hospital's administrative department to express interest to conduct the study. Once approval was obtained from the hospital administration (Appendix 6), screening questionnaires were distributed to the administrative staff (Appendix 7). Fourteen administrative office workers were selected at this hospital and screened for eligibility. Nine respondents were potentially eligible and two met the inclusion criteria. Due to time constraints, one participant was selected for this study.

- **Sampling (inclusion and exclusion criteria):**

The following inclusion criteria were applied:

- English proficient, 18-65 years of age, who worked on the computer for five hours a day

- Experienced computer related neck and upper back symptoms between the occiput and T7 horizontally, and between the distal end of the acromion laterally
- Had an adjustable office chair, and sufficient space to accommodate a VDT/ laptop adjustment. If they used a laptop, they should have been willing to use an external keyboard/ mouse during the period of the study.
- The habitual seat height and/ or VDT height that were not within the 10-15% seat and VDT height calculated for the participant using the PC- SAFE guidelines (Hochanadel, 1995)

Participants were excluded if:

- They scored 4-5 on the STarT screening tool - to exclude psychosocial confounding factors (Generic Condition Tool, 2014)
- Had a BMI of >30
- Chronic smokers
- Pregnant ladies
- Undergone previous cervical or upper thoracic surgery or previous whiplash
- Experiencing neurological symptoms/ other specific pathology e.g. Rheumatoid Arthritis
- Wore bifocals or varifocals; as they influence the head orientation angle

- **Recruitment and informed consent:**

Eligible participants who met the inclusion criteria had to undergo a second screening to measure their habitual workstation parameters. The 'adjusted' chair seat height and VDT height was then calculated (Appendix 9). The participant was included only if the mismatch between the habitual and the adjusted parameters was not within 10- 15% of the height that is meant to be used for the intervention.

The participant underwent an interview and a physical examination to complete the entry questionnaire (Appendix 8). This excluded any red flags and psychosocial factors as potential contributing factors. The study was explained to the participant in detail with respect to the three different phases and written informed consent was obtained.

2.3.5 Study setting:

The study was conducted at the participant's place of work, a private hospital in Cape Town.

2.3.6 Study population:

The study participant was an office worker who complained of computer related neck and upper back symptoms.

2.3.7 Description of the Intervention:

The habitual chair seat height and the VDT height were measured during the second screening using a standard tape measure. The adjusted VDT height and the adjusted chair seat height were calculated according to the PC SAFE guidelines (Personal Computer Self Adjusting Functional Ergonomics) (Hochanadel, 1995). The mismatch between the habitual and the adjusted chair seat height and the VDT height were thus calculated. The results obtained are documented in Table 2.2.

During the intervention, the chair seat height was raised to 675mm by adjusting the lever. The VDT height was raised using a pre-fabricated wooden box to 1365 mm. No other ergonomic intervention or advice was offered to the participant.

2.3.8 Outcome Measurement:

The outcome measures selected included the Visual Analogue Scales (VAS). The primary outcome measure obtained was the VAS for pain intensity, while the secondary outcome measure was VAS for perceived comfort. The VAS is a self-report instrument, consisting of a line 100mm apart on which the participant would indicate the intensity of pain and the comfort of sitting posture.

- **VAS for Pain intensity:** The VAS line has a starting point on the left indicating 'No Pain' and the end point on the right representing 'Worst Possible Pain'. The participant was instructed to mark the intensity of their pain on the horizontal line.
- **VAS for Perceived comfort:** The left margin marked 'Very comfortable' and the right margin 'Extremely uncomfortable'. The participant was instructed to mark the intensity of perceived comfort on the horizontal line.

The reliability and validity for VAS outcomes has been established (Gajasinghe et al., 2010; Hawker et al., 2011). The minimal clinically important difference (MCID) has been shown for chronic conditions, such as rheumatoid arthritis and rotator cuff disease to be between 11 and 13.7 mm out of one hundred (Hawker et al., 2011).

The VAS for pain intensity and VAS for perceived comfort were obtained biweekly during each phase of the study. A once off measurement was conducted three months after the third (last) phase. All outcome measure questionnaires were placed in a sealed box, and collected at the end of each phase.

2.3.9 Measurement of known confounding factors

2.3.9.1 Pain medication taken and other treatment received:

The outcome measures questionnaire (Appendix 10) included a section for the pain medication taken over the past two days as this could influence the results of the outcome measures. Details regarding the pain medication could provide a tool to determine the influence of the intervention, or the contribution of the pain medication.

2.3.9.2 Phase end questionnaire:

Upon the completion of each Phase A and B, the subject completed an end of phase questionnaire (Appendix 11). The objective of this questionnaire was to identify any other contributing factors that could have played an influential role on the outcome measures.

2.3.9.3 Exit questionnaire:

At the end of Phase C, the participant completed an exit questionnaire (Appendix 12). The questionnaire also comprised of various questions to rule out any other confounding factors that could have influenced the outcome measures.

2.3.9.4 Follow up and Exit Interview:

The participant underwent an exit interview three months after completion of the study. The outcome measures for pain intensity and perceived comfort were obtained. Details regarding the following were also obtained: Pain medication used, absence from work, any intervention for the pain or discomfort e.g. Physiotherapy/

Chiropractic treatment, adjustments made to the workstation, STarT tool to determine any psychosocial contributing factors, measurements of the chair seat height and the VDT height of the current work station

2.3.9.5 Data analysis:

The data obtained at the end of each phase was captured on a Microsoft Excel 2010 spreadsheet. Data was analysed descriptively. The mean values for the pain intensity and comfort were calculated as well as the range during each phase. The data and the means for the pain intensity and comfort were represented as line graphs to show the variation during and between the phases.

2.4 RESULTS

2.4.1 Participant description

The study participant was a 43year old female working full time as a creditor clerk at a large private hospital in the southern suburbs of Cape Town. She presented with a two year history of neck and upper back pain and discomfort. She reported significant association of her musculoskeletal symptoms with sitting for prolonged periods while using the computer at work. Her work entailed input of stock data for all the patients in her allocated wards. She reported an increase in her symptoms at the beginning of the week as she would have to feed in the data of the weekend, as well as the beginning of the week. Her symptoms would also increase if there was a decrease in staff at the accounting section of the hospital's administrative division. Occasionally a Panado or a massage would give her some relief of her neck and upper back symptoms. She reported using vision glasses for the past ten years, but was not sure of the prescription with respect to the distance they were trying to correct.

She had her current position for four years and became aware of her neck and upper back symptoms two years ago. It started gradually and was not related to any previous trauma or surgery. It had not been increasing in intensity, but she experienced a persistent dull and nagging pain for the past two years. The pain was accompanied with discomfort in the same area. There was no radiating pain to the hands. On physical examination restriction of movement was noted with cervical

extension and rotation to the right, eliciting her pain. She had asymptomatic thoracic and shoulder movements (left and right). The C5/6 intervertebral level was stiff and painful on palpation with a unilateral postero-anterior movement to the right side. See Table 2.1 for a detailed participant description.

Table 2.1: Participant description:

Age	43 years
Sex	Female
Job description	Accounts controller: Stock input for all the patients in three wards: ICU, Neurosciences and the Eye clinic
VDT hours per day	8am- 5pm (8-9 hours per day)
Pain area	Neck and upper back Right Upper Trapezius area > Left side non- radiating
Pain onset and duration	For the past two years, gradual onset, not related to any trauma, surgery.
Nature of pain	Niggling, discomfort, persistent pain/ ache
Duration of symptoms	Persistent pain for two years
Aggravating factors	<ul style="list-style-type: none"> - Prolonged working hours - Shortage of administrative staff - Increase in pain on Mondays and Tuesdays, while she is trying to catch up with the weekend's work
Easing factors	<ul style="list-style-type: none"> - Massage - Occasional Panado - Left side flexion
Red flags	None
Physical examination	<p>Movement:</p> <ul style="list-style-type: none"> - Pain and end range restriction on cervical extension - Pain and end range restriction on right rotation - All other cervical movements full and pain free - Asymptomatic thoracic and shoulder movements (right and left) <p>Palpation:</p> <ul style="list-style-type: none"> - Stiff and painful C5/6 on right unilateral postero-anterior movement - Tender Upper Trapezius R > L

2.4.2 Participant's workstation measurements:

A physical examination was conducted of the participant's workstation using a standard tape measure. The habitual chair seat height and VDT height were measured. The chair seat height mismatch calculated was 38%, while the VDT height mismatch was calculated to be 13%. For the participant to be included in this study there should have been a mismatch of 10-15% in either one of the vertical

parameters. The participant in this study had a mismatch in both the chair seat height and the VDT height. Table 2.2 shows details of the participant's workstation measurements. Figure 2.1 illustrates the habitual workstation of the participant. Post height adjustment of the VDT and chair, the participant's workstation is depicted in Figure 2.2

Table 2.2: Participant's workstation measurements:

	Habitual	Adjusted height- Intervention Phase B	Mismatch
Chair seat height (mm)	490	675	38%
VDT height (mm)	1210	1365	13%



Figure 2.1: Illustration of the participant's habitual

workstation:

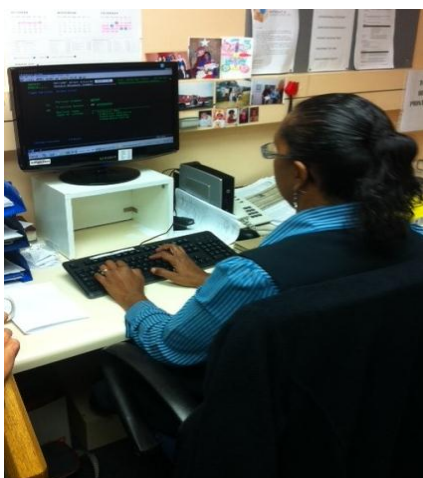


Figure 2.2: The participant's workstation during Phase B (intervention)

2.4.3 Outcome measures:

The primary outcome measure was the VAS for pain intensity, while the secondary outcome measure assessed was the VAS for perceived comfort, obtained biweekly during each phase. Table 2.3 illustrates the findings of the outcome measures obtained throughout the three phases of the study. The lowest mean VAS for pain intensity recorded was 14.75 /100 which was obtained during Phase A. The highest value recorded was 19.38/100 obtained during Phase C. The lowest mean VAS for perceived comfort was 8.75/ 100, obtained during Phase A. The highest value recorded was 18.25/100 obtained during Phase B.

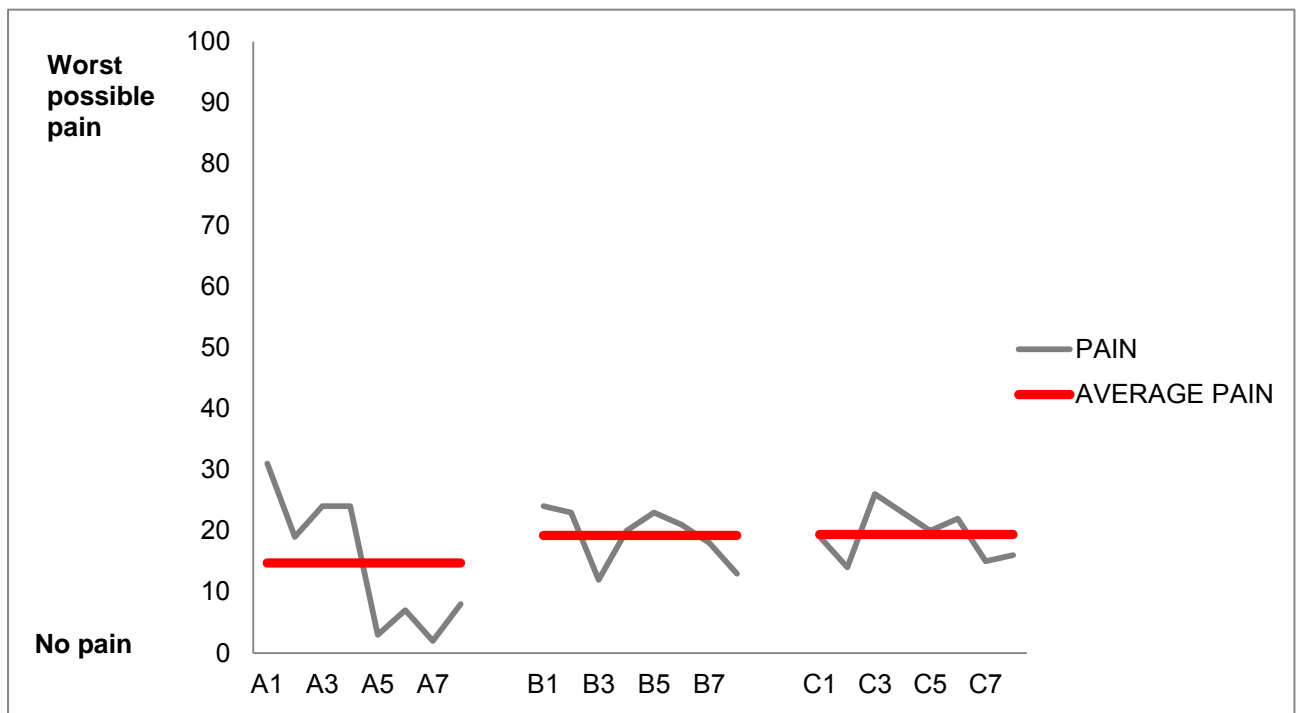
Table 2.3: Outcome measures: VAS for pain intensity, VAS for perceived comfort

	PHASE A		PHASE B		PHASE C	
	VAS- Pain Intensity	VAS- Perceived Comfort	VAS- Pain Intensity	VAS- Perceived Comfort	VAS- Pain Intensity	VAS- Perceived Comfort
	31	16	24	23	19	17
	19	22	23	16	14	17
	24	15	12	15	26	21
	24	12	20	17	23	14
	3	2	23	27	20	12
	7	1	21	14	22	10
	2	0	18	14	15	18
	8	2	13	20	16	17
MEAN (-/100)	14.75	8.75	19.25	18.25	19.38	15.75
RANGE (mm)	2-31	0-22	12-24	14-27	14-26	10-21

- **VAS for pain intensity:**

Figure 2.3 graphically depicts the self-reported pain scores. In comparison to Phase A and Phase B, there was an increase in the mean pain intensity experienced by the participant in Phase C. The maximum amount of pain experienced by the participant was at the initial phase (31/100) which reduced in the subsequent phases; Phase B (24/100) and Phase C (26/100). The variation of pain intensity was the highest in Phase A (2-31), while more consistent values were obtained in Phase B (12-24) and Phase C (14-26).

Figure 2 3: VAS for pain intensity during the phases

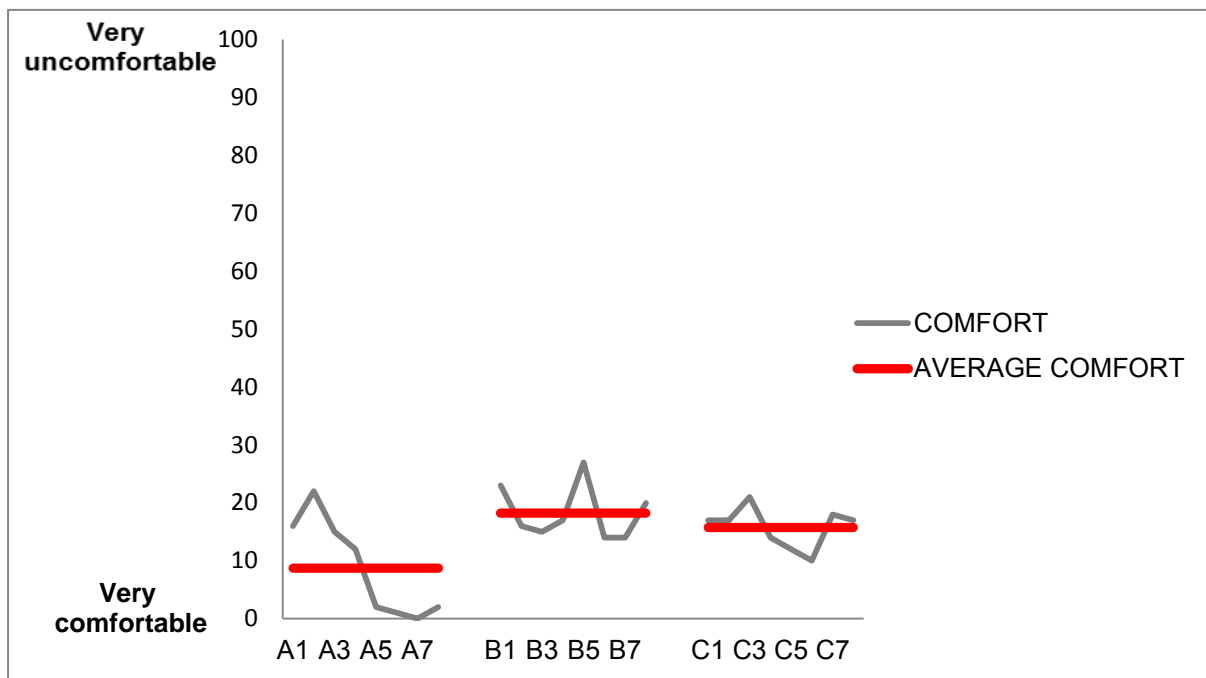


- **VAS for perceived comfort**

Figure 2.4 reports the VAS for perceived comfort during the study phases. The VAS for perceived comfort had 'Very comfortable' on one end of the scale and 'Extremely uncomfortable' on the other end. A lower value on this scale was an indicator that the participant felt more comfortable at the workstation.

During Phase B, the mean perceived comfort obtained was 18.25 /100 indicating the participant was more uncomfortable in comparison to Phase A and C. The variation of the comfort levels was higher during Phase A (0-22), while more consisted values were obtained during Phase B (14-27) and Phase C (10-21).

Figure 2.4: VAS for perceived comfort during the phases



- **Pain medication:**

The participant reported that she had not taken any pain medication during any of the three phases of the study. During the initial assessment, the participant reported the use of an occasional Panado for pain relief.

- **End of phase questionnaires:**

End of phase questionnaires were completed at the end of Phase A and B to obtain information on any external factors that could be contributing to the participant's neck and upper back symptoms. Table 2.4 shows that there were no specific factors noted that could have confounded the findings.

Table 2.4: End of phase questionnaires

	End of Phase A	End of Phase B
Absence from work over the past 4 weeks	No	No
Treatment for the neck and upper back over the past 4 weeks	No	No
Adjustments to the workstation over the past 4 weeks	No	No
Any factors influencing the neck and upper back pain / comfort over the past 4 weeks	No	No

- **Exit questionnaire:**

At the end of phase C, the participant completed an exit questionnaire to identify any external contributing factors which may have influenced her neck and upper back symptoms over the four weeks of the study phase C as well as the three month study period. Table 2.5 shows a summary of the results of the exit questionnaire.

A very important response to note was that the participant felt that the chair seat height and the VDT height were too high for her. She did not however make any adjustments to the setting despite having the option to adjust the setting to where she would feel comfortable.

Table 2.5: Exit questionnaire results

		End of Phase C
1.	Absence from work over the past 4 weeks	No
2.	Treatment for the neck and upper back over the past 4 weeks	No
3.	Adjustments to the workstation over the past 4 weeks	No
4.	Any factors influencing the neck and upper back pain / comfort over the past 4 weeks	YES: Chair height and VDT height too high
5.	Changes in nature of work over the past 3 months	No
6.	Changes in the physical work environment over the past 3 months	No
7.	Frequency of breaks from sitting work	Every 2hours (similar during 3month study period)
8.	Changes in physical activity (exercise) over the past 3 months	No
9.	Changes in family/ social life over the past 3 months	No
10.	Accidents/ injuries that may have affected neck and upper back symptoms over the past 3 months	No
11.	Changes in the general health over the past 3 months	No
12.	Changes in the mattress over the past 3 months	No
13.	Changes in the pillow over the past 3 months	No
14.	Changes in the glasses prescription over the past 3 months	No

2.4.4 Three month follow-up interview:

The participant was reviewed three months after completion of the study to evaluate her neck and upper back symptoms as well as her workstation parameters. The participant reported significant improvement in both her symptoms of pain intensity and perceived comfort. There was a marked reduction in the VAS for pain intensity at the three month follow up (5/100) in comparison to the mean VAS for pain intensity during the phases (Table 2.6).

Table 2.6: Comparison of VAS for pain intensity

	Phase A	Phase B	Phase C	3-month follow up (once off measurement)
Mean VAS for pain intensity (-/100)	14.75	19.25	19.38	5

There was also a reduction in the VAS for perceived comfort at the three-month follow up (10/100) in comparison to the mean VAS for perceived comfort during the phases. Table 2.7 shows the comparison.

Table 2.7: Comparison of VAS for perceived comfort

	Phase A	Phase B	Phase C	3-month follow up (once off measurement)
Mean VAS for perceived comfort (-/100)	8.75	18.25	15.75	10

According to the initial examination prior to commencing the study, the participant's chair seat height and VDT height were deemed low according to the PC SAFE guidelines (Hochanadel, 1995). At the end of the study, the participant reported that the chair seat and VDT height was 'too high'.

On the three month follow up after completion of the study her vertical parameters were re-measured. She had lowered both the chair seat height and the VDT height. The chair seat height was lowered by 95mm compared to Phase B, but was higher than the habitual set up by 90mm. In comparison to Phase B, the VDT height during the three month follow up was lowered by 70mm, which was more than the habitual height by 85mm. Table 2.8 provides a summary and comparison of the chair seat heights and the VDT heights.

Table2.8: Vertical workstation parameters

	Habitual	Adjusted height- Intervention Phase B	3month follow up
Chair seat height (mm)	490	675	580
VDT height (mm)	1210	1365	1295

Overall the participant reported an increased awareness of her body position sense after partaking in the study and appreciated the adjustments made to her chair seat height and VDT height. She reported that her chair felt more comfortable as the

elbow was slightly higher so did not have to strain her neck. She did not look straight at the VDT screen, but had to look slightly downwards. She acknowledged that the adjustments in the chair seat height and the VDT height had contributed to the improvement of her symptoms during the three month follow-up period.

2.4.5 STarT Screening Tool:

The STarT scores were measured at the beginning of the study, at the end of the study and at the 3month follow up interview. It was measured to exclude any psychosocial contributing factors. The participant obtained a score of 0/5 in all measurements, excluding any psychosocial contribution to her symptoms.

2.5 Discussion:

The 45year old female selected for this study complained of neck and upper back pain and discomfort for the past two years. This is a common complaint for habitual computer users, which has been documented to have a higher incidence in females compared to males (Cagnie et al., 2007; Johnston et al., 2008; Johnston et al., 2010; Szeto et al., 2005; Widarnarko et al., 2011).

The findings of this study reveal that the intervention height of the chair and the VDT to maintain a horizontal viewing angle did not improve the participant's pain intensity and perceived sitting comfort. However during a three month post-intervention follow up, the participant showed marked improvement in her pain intensity and perceived sitting comfort. During this follow up interview, she had adjusted the chair height and VDT height so that it was lower than the horizontal intervention height, but higher than her habitual set up, resulting in a slightly downward gaze.

During the baseline phase of this study, the mean intensity of pain was lower than expected. The pain was higher during the first half of the baseline phase, whilst a marked reduction was seen during the latter part. This reduction in pain coincided with the Western Cape school holiday which is a period of lesser activity at the hospital, as many doctors are on vacation, reducing the workload for the administrative staff. Cho et al reported that computer users with a high workload complain more of musculoskeletal symptoms than the lower workload group (Cho, Hwang, & Cherng, 2012). The mean pain intensity reported by the participant in

Phase A could be attributed to the decrease in work load levels at the hospital during the last two weeks of Phase A. The latter part of the baseline phase A, may therefore not have been a true representation of the symptoms experienced by the participant on a normal basis. This factor should be controlled for in follow-up studies, but due to the time-constraints of data collection for this study, it was not possible.

The average pain intensity reported by the participant during the intervention phase was higher than the baseline phase. The doctors at the hospital resumed their regular work schedule during this period, thereby normalising the participant's workload. This could attribute to the relatively higher average pain intensity reported for the participant during this phase. It was also noted that the maximum pain intensity reported by the participant during the intervention phase was lower than the maximum pain reported during the baseline phase (Table 2.3). This could be a reflection of the effect of the intervention. In addition, the pain variability was less during the intervention phase and could possibly be related to the altered VDT and seat heights. However, the mean pain during the intervention phase did not improve.

Only self-perceived outcomes were measured and objective measures such as posture was not evaluated. Photographs were taken for general descriptive purposes. The photograph (Figure 2.1) of the participant during Phase A indicates a slight increase in cervical flexion, while during Phase B there was a slight increase in upper cervical extension (Figure 2.2). However, we are uncertain if these postures were maintained throughout the respective phases. It can be assumed that the participant adopted an increase in upper cervical extension due to the height adjustment of the VDT and chair, as well as accommodation of the viewing angle due to the vision correction glasses she used. Future research is recommended to assess the postural changes in subjects following vertical dimension adjustments at the workstation.

The third phase showed a slight increase in the mean pain (Table 2.3) compared to the baseline and the intervention phase. The range of pain intensity during Phase C was similar to Phase B. The participant reported that the adjustment of both the chair and VDT were too high for her. This could explain why her pain intensity did not show significant improvements and affirms that the intervention did not exacerbate her symptoms.

During the third phase, the participant was allowed to change the chair seat and VDT settings to what she would deem comfortable, or leave the settings as it was. She opted not to adjust the settings. This affirms that the intervention was not harmful, albeit it may not have elicited significant improvements. Workers with low disability will continue working, as it would be difficult for them to remain productive with high levels of disability (Paksaichol et al., 2014). It also can be assumed that the pain intensity reported during this phase is what she would experience regularly.

The second outcome measure studied was the response of perceived sitting comfort following the adjustment of the VDT and chair height. During the baseline phase of this study, the participant reported a higher level of comfort (Table 2.3). This could be attributed to the lower levels of work load due to the vacations during that period. There could have been an association between the reductions in the average pain intensity of the participant with lower VAS scores indicating increased perceived sitting comfort.

During the initial part of the intervention phase the participant reported an increase in the discomfort levels (Table 2.3). The participant had been working at this set up for the past two years, therefore the initial discomfort during the intervention phase could be attributed to the sudden change that occurred in her habitual set up, and possibly adopted an uncomfortable posture, which has been seen to increase the odds of pain and discomfort (Johnston et al., 2008). As the participant got accustomed to the setting, her comfort levels improved and were more consistent. O'Brien et al also reported that participant's involved in research studies receive rapid feedback to inform them that the conditions are improving, therefore increasing their comfort and satisfaction with the changes made as the study progresses (O'Brien & Gunay, 2014).

During Phase C, there was a notable reduction in the participant's VAS scores for perceived comfort levels, indicating the participant was more comfortable during this phase. The perceived sitting comfort levels improved and were more consistent during this phase, unlike the pain intensity. The participant may have exercised psychological coping mechanisms such as ignoring or tolerating the source of discomfort (O'Brien & Gunay, 2014). Perhaps due to this the participant in this study reported that the intervention height was 'a bit high' for her, yet her comfort

increased during the third phase. She did not attain maximum comfort either. Poor biomechanics can turn comfort into discomfort, but good biomechanics is also not sufficient enough for a subject to experience comfort (Helander & Zhang, 1997).

When reviewed after three months, the participant reported marked improvements in pain and comfort. She reported that she re-adjusted the heights of the chair seat and VDT and made these slightly lower than the intervention phase. Amick et al (2012) support the use of an adjustable chair and reports that the chair height has the potential to influence the viewing angle and the distance from the VDT (Amick et al., 2012). According to Burgess-Limerick a subject adjusts the viewing angle by changing the neck position, or adjusting their trunk, or by moving the eyes only (Limerick et al., 1999). It is difficult to deduce which technique the participant in this study opted for as there was no constant observation of her posture adjustment. According to Sommerich et al (2001) the optimal viewing angle is often found to be slightly below the horizontal so as to attain a balance between musculoskeletal symptoms and eye comfort (Sommerich et al., 2001). The participant's chair seat and VDT heights after the study were lower than during the intervention phase, thereby encouraging a slightly below horizontal viewing angle.

According to Straker et al, lower VDT heights increase the head and neck flexion (Straker et al., 2008c). They also concluded that there is no significant difference in using high-or-mid-display heights in terms of postural alignment and muscle activity. Straker et al found that mid-displays improve the oculomotor function thereby improving comfort (Straker et al., 2008a). The study participant acknowledged that she preferred the self-adjusted position which is comparable to the mid position in the literature and was grateful for the intervention since she was more aware of her posture. She reports that her habitual workstation was too low for her, but the intervention workstation was too high. This also implies that the worker plays a crucial role to optimise the effectiveness of an ergonomic intervention (Bidassie 2010).

2.6 Study strengths and limitations

- Study design:

The study was an N=1 study and the nature of this design is that the patient acts as his own control. These types of designs are now viewed as high quality evidence for the effect of an intervention (McMaster University, 2014) for a specific individual as all known and unknown confounders are controlled. However, the limitation is that the findings are not generalizable to the population.

Convenience sampling was conducted due to time constraints creating the possibility of participation bias. Therefore, the application of the findings to the general population is compromised.

A strength of this study was that it focussed on a single intervention. Many studies into computer-related spinal pain assessed multi-modal interventions. It becomes difficult to discern which intervention can be attributed to the outcomes. The chair seat height and the VDT heights were adjusted simultaneously and therefore the individual effect of either one of these adjustment cannot be determined. Performing each adjustment independently could possibly be addressed in future studies.

The intervention phase involved a sudden vertical adjustment of both the chair seat height and the VDT height. A gradual height adjustment of each parameter and assessment of the outcome measures during each phase would have provided a better indication of the response of the tissues to the ergonomic intervention. No evidence of research into this specific area could be found, therefore further research is advised.

The duration of each phase was four weeks long and this may not have been sufficient time for the participant's neuro musculoskeletal system to accommodate to the expected physiological changes within the tissues. An increase in the duration of each phase could thus be recommended to allow the neuro-musculoskeletal system to adapt to the changes due to the vertical adjustment of the chair seat height and the VDT height.

Similarly the duration of the study was three months, whilst marked improvements in the outcome measures of this participant were only seen after six months. Computer related neck and upper back pain is chronic therefore increasing the time frame of the study could be beneficial to assess the long term effects and benefits of the ergonomic intervention.

In addition, as the duration of each phase was only four weeks, additional data per phase could not be collected. A larger number of data points per phase would allow more complex statistical techniques for single subject designs such as split-middle techniques.

- Outcome measures:

Subjective outcome measures were used for this study. The response variability is reduced when using subjective outcome measures creating the possibility of a response bias. According to Lanzotti et al the differences perceived while using subjective outcome measures are small (Lanzotti, Trotta, & Vanacore, 2011). In this study the differences obtained for the VAS for pain intensity and VAS for perceived comfort are relatively small. The minimal clinically important difference in chronic conditions has been reported to be between 11-13.7 mm out of a hundred (Hawker et al., 2011). Therefore the small changes obtained in this study for VAS for pain and VAS for perceived comfort may indicate improvement, but not deemed clinically significant.

2.7 Recommendations for future research

Larger studies can be recommended to assess individual responses to this type of intervention and to allow extrapolation of these findings to the general population.

The intervention phase involved a sudden vertical adjustment of both the chair seat height and the VDT height. A gradual height adjustment of each parameter and assessment of the outcome measures during each phase would have provided a better indication of the response of the tissues to the ergonomic intervention. Since there is no research into this area specifically, further research is recommended.

Outcome measures aimed at assessing the work load would have been beneficial to link the changes in the reported symptoms either to the intervention, or to alterations in the work demands. The level of disability would also be worth studying further to assess the level of disability prior to and after the intervention.

2.8 Conclusion:

The aim of the study was to assess whether the vertical adjustment of the chair seat height and the VDT height would reduce the pain intensity of the neck and upper back area and improve the perceived sitting comfort in an office worker who predominantly used a computer.

The findings of this study do not support the horizontal viewing angle, but does support a long term follow up in favour of a 'slightly below horizontal viewing angle.' This study also supports the use of participatory ergonomics, whereby the participant alters the setting based on increased awareness of their body's alignment to ensure they attain a more comfortable position.

Further research assessing the changes in the musculoskeletal system with a gradual increase in the vertical parameters would be beneficial to assess the participant's response at each level of height increment. Longer time-frame follow ups are also recommended to assess the maintenance of the effects.

CHAPTER 3: SUMMARY AND CONCLUSION

3.1 Contribution of study to knowledge

The aim of this study was to determine whether a simple ergonomic intervention that involved adjusting the vertical parameters of the chair and the computer screen height would influence the computer user's neck and upper back pain.

The study conducted was an N=1 study which is beneficial as the confounding factors are controlled, therefore giving a reflection of the effects of the intervention. This study consisted of an A-B-C design, with each phase spanning four weeks. The participant selected was a forty three year old female, working on the computer for more than five hours per day. She had been experiencing chronic neck and upper back pain, which she associated with prolonged computer use.

The outcome measures selected were self-report VAS for 'pain intensity' (primary outcome) and 'perceived sitting comfort' (secondary outcome). Two outcome measure forms were obtained per week, for four weeks over each of the three phases. An exit questionnaire was completed at the end of the study, followed by a follow up interview three months after the end of the study.

The results revealed a slight increase in the pain intensity of the participant during the intervention phase. The perceived comfort levels demonstrated slight deterioration during the intervention phase. The pain intensity remained steady after the intervention, and the perceived comfort indicated slight improvements in the third 'washout phase'. The variability of the pain intensity and perceived comfort was also less following the intervention indicating consistency in the participant's findings. The participant had however reported that the intervention set up was 'too high' for her.

The three month follow up interview revealed marked improvements in the participant's pain intensity and perceived sitting comfort levels. This change can be attributed to the workstation adjustment the participant performed independently.

The new chair seat height and VDT height were lower than the intervention setting, but higher than her habitual set up. She reported a reduction in the pain intensity and improved perceived sitting comfort with a mid-display, and not the intervention's high display (horizontal viewing angle). The results of this study support the slightly below horizontal viewing angle, as opposed to the intervention's horizontal viewing angle.

3.2 Clinical implications.

The participant initially appeared to be looking down due to the low placement of the habitual chair and VDT. 'Low displays' are associated repeatedly with an increase the neck and upper back pain in computer users, with no information in the literature supporting the use of a low display.

Conflicting recommendations are reported, some supporting the horizontal viewing angle (high displays), others supporting a slightly below horizontal viewing angle (mid-displays). Neither the high nor mid displays were reported to be superior with respect to muscle activity patterns. The intervention in this study was aimed at positioning the participant so that the viewing angle would be as near to the horizontal angle as possible. The participant however reported that this set up was 'too high' for her.

The results of this study re-affirm the influence of the vertical parameters on neck and upper back pain, and modification of these parameters can help reduce the symptoms experienced by the participant. The self-adjustment of the chair setting and VDT setting, to facilitate the 'slightly below horizontal viewing angle' or the 'mid-displays' is supported with this study. This finding may be beneficial to other patient's with similar profiles to this study's participant.

3.3 Recommendations for future research

This study examined a single ergonomic intervention of adjusting the vertical parameters of the chair and the VDT height. The possible confounding factors were assessed and excluded. Therefore the results of this study can be directly attributed to the intervention.

Another possible reason for the lack of significant change during the intervention was the sudden change in the heights of the chair and VDT. The participant was accustomed to her set up for the past four years. A sudden change to two components of the workstation may not necessarily be accepted comfortably by the body. It is recommended that a gradual height increment and the effects of each phase could be more beneficial to identify 'heights' that are comfortable, and those that are not comfortable for the office worker. This can also provide further insight into the benefits of the high display, or the mid-display.

The outcome measures selected were the VAS scales for pain intensity and perceived sitting comfort. Further studies assessing the 'disability' could be beneficial to see the impact the neck and upper back pain has on the participant and the changes elicited by an intervention.

It can be hypothesized that a raised VDT leads to an increase in upper cervical extension, which could possibly be a reason for the increase in the participant's symptoms. Further research to assess the posture of the participant, and the changes elicited with the interventions would be helpful. Analysis of posture via photographs, Vicon labs, etc would give insight to the impact of the intervention.

Studies with more participants are recommended to extrapolate these findings to the general population. Long term follow-ups are also recommended as neck and upper back pain in computer users is often chronic and persistent.

3.4 Conclusion.

The findings of this study suggest that the vertical height adjustment of the chair and the VDT influences the neck and upper back pain of the computer user. The intervention height selected did not improve the participant's pain intensity and perceived comfort, but a slightly lower height appeared to be more beneficial. Further research is recommended to assess the benefits of a mid-display on the neck and upper back pain and perceived sitting comfort of the computer user.

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Appendix 1: Summary of interventions

Author	Target population	Intervention	Results
Bernaards, Ariens, Knol, & Hildebrandt, 2007	Computer workers	<ol style="list-style-type: none"> 1. Group one: Work-style group: increasing awareness of coping with high work demands and adjustments of workplace accordingly. 2. Group two: Work style + lifestyle Physical Activity-: moderate to heavy intensive physical exercise 3. Control: no intervention 	There was no significant difference in neck pain measured at intermediate-term or at long term follow up between the experimental and control groups
Fostervold, Aaras, & Lie, 2006	Computer workers	<ol style="list-style-type: none"> 1. Intervention: computer screen angle set at high line of sight (15° lower than horizontal line to the midpoint of the screen) 2. Control: computer screen angle set at low line of sight (30° lower than a horizontal line to the midpoint of the screen) 	There was no significant difference at short term follow up on the prevalence of neck pain in the intervention group.
Kamwendo & Linton, 1991	Medical secretaries sitting at work for 5hours daily	<ol style="list-style-type: none"> 1. Intervention group one: Traditional neck school: education about body function and ergonomics, included pause-gymnastics and relaxation 2. Intervention group two: Reinforced neck school: interview by a psychologist on psychosocial work factors to arrive at a personal coping strategy 3. Group three: control group: No care 	There was no significant difference between the intervention and control group on pain and sick leave
Ketola et al., 2002	Computer workers	<ol style="list-style-type: none"> 1. Intervention group one: intensive ergonomics: work site visit included taking breaks during work, paying attention to work posture, active participation of the worker. 2. Intervention group two: ergonomic education: group training session, encouraged to take short pauses 3. Control group: no care received 	There was significant reduction in the pain severity in both intervention groups: at short term follow up but not at intermediate term follow up
Van den Heuvel, de Looze, & Hildebrandt, 2003	Computer workers	<ol style="list-style-type: none"> 1. Intervention group A: Rest breaks: five minutes rest every 35minutes introduced by a computer program 2. Intervention group B: rest breaks + exercise: four physical exercises of 45 seconds duration 3. Group C: ergonomic adjustments of the work place, and received a booklet 	Pain intensity improved in both intervention groups in comparison to the control groups, but not statistically significant
Voerman et al., 2008	Job counsellors, medical secretaries	<ol style="list-style-type: none"> 1. Group one: ambulant myo-feedback training combined with ergonomic counselling to relax based on the feedback. 2. Control group: ergonomic counselling: 	No significant difference in the pain and disability between both groups

		workplace visit including ergonomic investigation and modification of the existing workstation	
Gerr et al., 2005	Computer workers	<ol style="list-style-type: none"> 1. Intervention group one: alternate intervention: postural intervention with workplace changes based on the results from a prospective study on musculoskeletal disorders. 2. Intervention group two: Conventional interventions: postural intervention with workplace change based on OSHA, NIOSH and private industry recommendations 3. Group three: control: no intervention: continue keying in usual posture and no workstation changes 	No statistical difference in reducing neck pain and prevalence between both intervention groups and the control group
Amick, Robertson, De Rango, Rooney, & Harrist, 2003	Office workers	<ol style="list-style-type: none"> 1. Group one; adjustable chair and training 2. Group 2; training only 3. Group 3: no intervention 	Group one: adjustable chair plus training resulted in less pain at the end of the day, and had an average reduction in pain (largest reduction was seen in the neck/ shoulder, followed by upper and lower back)

Appendix 2: SASP Guidelines for article submission

The following guidelines for authors are supplied online:

<http://www.physiosa.org.za/sites/default/files/JRL%20Guidelines%20Final.pdf>

GUIDELINES FOR AUTHORS

Contributions to the South African Journal of Physiotherapy are invited on any topic related to physiotherapy or rehabilitation. All articles that are submitted to the journal for publication must be accompanied by two questions with the correct answers.

Types of Manuscripts

1. Research
2. Case report
3. Clinical report
4. Technical report
5. Literature review
6. Short Report

All manuscripts should be accompanied by a reference list.

Legal Considerations

Contributions will be considered for publication in the South African Journal of Physiotherapy on condition that:

- They have not been published previously.
- They have not been submitted for publication elsewhere.
- The Publications Division of the SASP reserves the copyright of all material published.

Acceptance of manuscripts

All manuscripts will be reviewed by two appointed referees. Identities of both authors and reviewers will be kept confidential in order to eliminate bias. Most articles require revision, in which case the reviewers' comments will be returned to the authors for consideration and alteration.

Preparation and Presentation of Manuscripts

Articles

1. Articles should be restricted to between 2 000 and 2 500 words.
2. Three copies submitted should be typewritten with double spacing and wide margins.
3. A title page should be supplied as a separate sheet and include the name(s), qualifications and affiliation(s) of the author(s), together with addresses and telephone numbers (at home and at work).
4. Each article must be accompanied by an abstract of not more than 200 words. This should be on a separate sheet and should be intelligible without reference to the main text. Up to five key words should be included.
5. All abbreviations should be spelt out when first used.
6. The metric system is to be used throughout.
7. Headings must be presented in upper and lower case. Avoid using capitals only.
8. Authors must provide contact details; telephone numbers and email as well as postal address and institutional affiliation (hospital, University).

References

The accuracy and the completeness of references are of the utmost importance, and a maximum of 15 references per paper is required.

1. References in the Text of the Article When referring to more than one paper, place the names of the principal authors in alphabetical order, e.g. Armstrong (1990), Jones (1988) and Smith and Jones (1990) refer to similar findings. When there are two authors of a paper, mention both, e.g. Smith and Jones (1990), but when there are three or more, mention only the principal author and follow with et al, e.g. Thomas et al (1980).

When citing an author's work within a sentence in the main text of your article, follow these examples:

- Smith (1982) refers to the length of time taken for the subject to respond to a stimulus.
- Smith and Jones (1990) refer to similar findings.
- Smith (1982) and Thomas et al (1980) refer to problems in the method.

If quoting directly from another author, place the words in inverted commas and include the page number on which the quotation appears. For example: The clinical significance of increased tension or interruption of free movement in neural tissues is well recognised..." (Yaxley and Jull 1990, p.143) (Reference: Allison G (editor) 1997 Australian Journal of Physiotherapy Guidelines for Authors. In: Scientific Writers' Handbook. Australian Journal of Physiotherapy (publisher): 117)

2. Reference list

This should appear at the end of the paper in alphabetical order. The author's name should be followed by the initials (unpunctuated) and separated from the next author by a comma. The names of all the authors should be cited and et al should not be used in the reference list. Next should follow the date of publication and then the details of the publication.

a) Journal articles. Having stated the authors and the year of publication, the title of the article should be given in full. There should be a full stop after the title. This should be followed by the full title of the journal (abbreviations should not be used), then the volume number (not the part number) followed by a colon and then the first and last pages of the publication. The required format is illustrated in the following example: Erickson M, Upshur C 1989 Caretaking burden and social support: Comparison of mothers of infants with and without disabilities. American Journal of Mental Retardation 94:250-258

b) Books. The format as illustrated in the example should be followed. (Note the use of punctuation and capital letters¹).

1) Payton OD 1994 Research: The validation of clinical practice, 3rd edn. Ppl 51-156. F.A. Davis Company, Philadelphia.

2) Shephard KF 1993 Questionnaire design and use. In: Bork CE (ed) Research in Physical Therapy, ppl76-204. J.B. Lippincott Company, Philadelphia

Illustrations

- Tables and figures should be kept to a minimum and be on separate sheets.
- Each table should be numbered and have a clear title. Tables should not repeat material stated in the text. All tables and figures must be referenced in the text in sequential order.
- Don't send photographs as an integral part of a Word document. Send them separately as a Jpeg file.
- All illustrations should be clearly marked on the reverse side with Arabic numerals, author's name and article, and an indication of the top side.
- All legends must be typed on a separate sheet.
- If a figure has been published before, the author must submit written permission from the copyright holder to reproduce the material.

Manuscript submission

- A covering letter, which must include the signature of each co-author, should accompany each manuscript.
- Permission to reprint figures, extracts or abstracts from other publications should be included with the manuscript on submission.

Appendix 3: Ethics approval



UNIVERSITEIT-STELENBOSCH-UNIVERSITY
FOR KNOWLEDGE and your KNOWLEDGE MATTERS

Approval Notice New Application

06-Dec-2013
van Vledder, Nicole N

Ethics Reference #: S13/10/215

Title: A simple ergonomic intervention for neck and upper back musculoskeletal pain in office workers.

Dear Ms Nicole van Vledder,

The New Application received on 11-Nov-2013, was reviewed by members of Health Research Ethics Committee 1 via Minimal Risk Review procedures on 04-Dec-2013 and was approved.

Please note the following information about your approved research protocol:

Protocol Approval Period: 06-Dec-2013 -06-Dec-2014

Please remember to use your protocol number (S13/10/215) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372

Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.

For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at 0219389156.

Included Documents:

CV Louw

Cv Saggu

Decl Muller

Decl Louw

Decl van Vledder
CV Williams
Protocol
Decl Erntzen
Protocol Synopsis
CV van Vledder
CV Muller
Decl Saggi
Checklist
Application Form
Cv Erntzen
Consent
Decl Williams

Sincerely,

Franklin Weber
HREC Coordinator
Health Research Ethics Committee 1

Investigator Responsibilities

Protection of Human Research Participants

Some of the responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the HREC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research.
2. Participant Enrolment. You may not recruit or enrol participants prior to the HREC approval date or after the expiration date of HREC approval. All recruitment materials for any form of media must be approved by the HREC prior to their use. If you need to recruit more participants than was noted in your HREC approval letter, you must submit an amendment requesting an increase in the number of participants.
3. Informed Consent. You are responsible for obtaining and documenting effective informed consent using only the HREC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least fifteen (15) years.
4. Continuing Review. The HREC must review and approve all HREC-approved research protocols at intervals appropriate to the degree of risk but not less than once per year. There is no grace period. Prior to the date on which the HREC approval of the research expires, it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in HREC approval does not occur. If HREC approval of your research lapses, you must stop new participant enrolment, and contact the HREC office immediately.
5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the HREC for review using the current Amendment Form. You may not initiate any amendments or changes to your research without first obtaining written HREC review and approval. The only exception is when it is necessary to eliminate apparent immediate hazards to participants and the HREC should be immediately informed of this necessity.
6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research-related injuries, occurring at this institution or at other performance sites must be reported to the HREC within five (5) days of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the HREC's requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Health Research Ethics Committee Standard Operating Procedures www.sun025.sun.ac.za/portal/page/portal/Health_Sciences/English/Centres%20and%20Institutions/Research_Development_Support/Ethics/Application_package All reportable events should be submitted to the HREC using the Serious Adverse Event Report Form.
7. Research Record Keeping. You must keep the following research-related records, at a minimum, in a secure location for a minimum of fifteen years: the HREC approved research protocol and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the HREC.
8. Reports to the MCC and Sponsor. When you submit the required annual report to the MCC or you submit required reports to your sponsor, you must provide a copy of that report to the HREC. You may submit the report at the time of continuing HREC review.
9. Provision of Emergency Medical Care. When a physician provides emergency medical care to a participant without prior HREC review and approval, to the extent permitted by law, such activities will not be recognised as research nor will the data obtained by any such activities should it be used in support of research.
10. Final reports. When you have completed (no further participant enrolment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the HREC.
11. On-Site Evaluations, MCC Inspections, or Audits. If you are notified that your research will be reviewed or audited by the MCC, the sponsor, any other external agency or any internal group, you must inform the HREC immediately of the impending audit/evaluation.

Appendix 4: Signed informed consent

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT: A simple ergonomic intervention for neck and upper back musculoskeletal pain in office workers.

REFERENCE NUMBER:

PRINCIPAL INVESTIGATORS: Mrs N van Vledder, Mrs S Muller, Ms R Saggu

ADDRESS: Division of Physiotherapy, Faculty of Health Sciences, Stellenbosch University, PO Box 19063, Tygerberg 7505, South Africa

CONTACT NUMBER:

- Nicole van Vledder on gavinix@hotmail.com or 0761019096
- Sabine Muller on sabinem@mweb.co.za or 0833754466
- Rajinder Saggu on rsaggu2@gmail.com or 0712777216

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or doctor any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

The aim of this study is to investigate the effect of modifying your office chair height and computer screen height on your neck and upper back pain. The study will be conducted in your office at your present workstation. Two participants from your office have been chosen to participate in the study. A similar study will be conducted at two other sites by two additional researchers, bringing the total number of participants to six.

The procedure is as follows: For four weeks your workstation will remain unchanged. During this time we will measure your symptoms biweekly using a questionnaire. You will be asked to score the intensity of your neck and upper back pain and the

perceived comfort of your work position over the previous two days. This will take less than one minute to complete and place in the folder provided. This phase allows us to establish your baseline symptoms when you are working at your usual work station.

Thereafter your workstation will be adjusted, and for a further four weeks biweekly monitoring of your symptoms will continue.

You will then be able to adjust your workstation to a setting of your choice should you wish to, and a final four weeks of biweekly monitoring will take place.

Why have you been invited to participate?

You have been invited to participate in this study because you are a computer-based office worker and suffer from chronic neck and upper back pain. You meet all the required criteria of the research study.

What will your responsibilities be?

You are expected to participate in this study for the duration of twelve weeks in total. This will involve completing the bi-weekly questionnaire and placing it in the slotted sealed box provided by the researcher.

During the first 8 weeks we request you not to change the height of your office chair or computer screen. Should you for any reason feel that an adjustment is necessary, please contact us.

Will you benefit from taking part in this research?

You may benefit from this research, as your workstation adjustment will be done according to recent evidence based literature. The results of our study may benefit others with similar symptoms related to office work which involves using a computer.

Are there in risks involved in your taking part in this research?

There are no additional risks from taking part in this study. In the event that the adjustments made to your workstation aggravate your neck and upper back symptoms please feel free to contact me.

If you do not agree to take part, what alternatives do you have?

You are able to have your workstation assessed by contacting a private physiotherapist, ergonomist or be referred to a professional in this field by the researcher. They would assess the possible contribution of your workstation to your neck and upper back pain.

Who will have access to your medical records?

All information provided by you will remain confidential and your identity will remain anonymous. No access to your medical records is necessary for the study.

Will you be paid to take part in this study and are there any costs involved?


You will not be paid to take part in this study, nor are there any costs involved for you, if you do take part.

Is there anything else that you should know or do?

You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your researcher.

You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I  agree to take part in a research study entitled '**A simple ergonomic intervention for neck and upper back musculoskeletal pain in office workers.**'

I declare that:

- I have read the attached information leaflet and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) PLUMSICAO On (date) 19 - MARCH 2014
2014.


.....

Signature of participant

Appendix 5: Letter to Constantiaberg Mediclinic Human Resources Department

University of Stellenbosch
Faculty of Medicine and Health Sciences
Tygerberg Campus
P.O. Box 19063
Tygerberg
7505
4 September 2013

Mediclinic Constantiaberg
Burnham Road
Plumstead
7800

Dear Mrs de Villiers

Re: Request to conduct a Physiotherapy Masters study at your premises.

We are Physiotherapy Masters students at the University of Stellenbosch. We are currently conducting a study to investigate the effect of adjusting the vertical workstation parameters of an office worker on their neck and upper back pain.

The study would take place at the workers' habitual workstation during office hours. It will require your administration staff to complete an initial screening questionnaire which will enable us to identify potential study participants. We will then measure the vertical workstation parameters of this group. Those workers whose workstation is deemed to be sub-optimal according to current evidence based literature will be eligible to participate.

The procedure will be as follows: For four weeks the subject's workstation will remain unchanged. During this time we will monitor their symptoms biweekly using a 2 item

questionnaire. They will be asked to score their pain level and the perceived comfort of their work position over the past 2/3 days. This will take less than one minute to complete and return to us. This phase allows us to establish their baseline symptoms.

Thereafter the workstation will be adjusted, and for a further four weeks biweekly monitoring of their symptoms will continue. The workstation will then be returned to the original setting, and a final four weeks of biweekly monitoring will take place.

In summary this will require the selected staff member to fill in a biweekly one minute questionnaire for a period of twelve weeks. Should the above be acceptable to you, kindly supply us with a brief letter of consent.

Regards

Nicole van Vledder, Sabine Muller and Rajinder Saggu

Appendix 6: A Letter from Constantiaberg Mediclinic

Letter from Constantiaberg Mediclinic

----- Original message -----

From: "De Villiers, Janine" <janine.devilliers@mediclinic.co.za>

Date: 04/09/2013 14:55 (GMT+02:00)

To: sabinem@mweb.co.za

Subject: FW: Physiotherapy Research

Dear Nicole,

I hereby confirm that we are willing to participate in the study utilising staff members from our Administrative department as your study participants.

I would also appreciate it, if possible, if you are able to provide us with your findings on its completion.

Kind Regards,

Janine de Villiers

Patient Administration Manager

MEDICLINIC CONSTANTIABERG

Burnham Road

Plumstead, 7800

PO Box 179

Plumstead, 7800

T +27 21 799 2911

F +27 86 682 7019

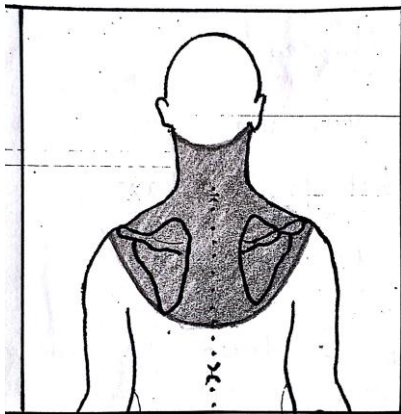
www.mediclinic.co.za

Appendix 7: Screening Questionnaire

SCREENING QUESTIONNAIRE

NAME: _____

Do you experience pain in the following shaded region whilst working on the computer?



Yes	No

If you have answered NO to the above question, please return the questionnaire

If you have answered YES to the above question, please fill out the following:

	YES	NO
1. Are you between 18 and 65 years old?		
2. Have you had this pain over the past 3 months?		
3. Are you planning on undergoing any treatment for this neck &/ upper back pain in the next 3 months?		
4. Do you experience more pain while working at your desk on your computer?		
5. Do you spend at least a minimum of 5 hours a day on your computer?		
6. If you work on a laptop, would you be prepared to use a separate keyboard/ mouse?		

7. Can your chair and computer screen height be adjusted?		
8. Do you wear bifocals/ varifocals while working?		
9. What is your weight? _____		
10. What is your height? _____		
11. Do you smoke?		
12. Are you pregnant?		
13. Have you had any trauma to your neck/ or upper back?		
Eg whiplash, falls, any other accidents?		
If YES please specify _____		
14. Have you undergone any surgical procedure to your neck/ or upper back? If YES please specify _____		
15. Have you planned on taking leave from work over the next 3months?		

Appendix 8: Entry Questionnaire

ENTRY QUESTIONNAIRE

Date:

1. Name:
2. Age:
3. Sex: MALE/ FEMALE
4. Upper Limb dominance: RIGHT/ LEFT
5. Occupation:
6. Frequency of breaks from sitting computer work: Shoe heel height commonly worn to work:
7. Hobbies:
8. Sports/ recreation:
9. Frequency of sports/ heavy physical activity causing sweating during the past 4 months?
 - a. More than 3 times/ week
 - b. 1-2 times/ week
 - c. 1-3 times/month
 - d. Less than 1time/month
10. **Social/family situation** (and any recent changes which may impact on the neck or upper back symptoms):
11. **GENERAL HEALTH:** If yes, what treatment are you currently receiving?
 - a. Rheumatoid arthritis:
 - b. Diabetes:
 - c. High Blood Pressure:
 - d. Osteoporosis:
 - e. History of Cancer:
 - f. History of Tuberculosis:
 - g. Unexplained night sweats:
12. **Have you undergone any recent surgeries?**
13. **Pharmaceutical history:**
 - a. Are you currently taking any medication for chronic diseases: please specify:

- b. Have you previously or are you currently taking cortisone for longer than a 2 week period?
- c. Are you currently taking any medication for pain relief? Please specify which one, and how often?

14. Have you noticed any of the following symptoms:

- a. Changes in the bladder and bowel patterns:
- b. Pins and needles in your hands and / feet :
- c. Changes in your walking pattern/ unsteadiness in the gait:
- d. Balance problems :
- e. Dizziness or fainting:
- f. Unexplained weight loss :

15. Participant's main complaint:

16. What is the participant's idea of causation, concerns, expectations regarding their neck and upper back symptoms:

17. History of neck and upper back symptoms

- a. **Current:**
- b. **Past Relevant:**

18. Specific questions

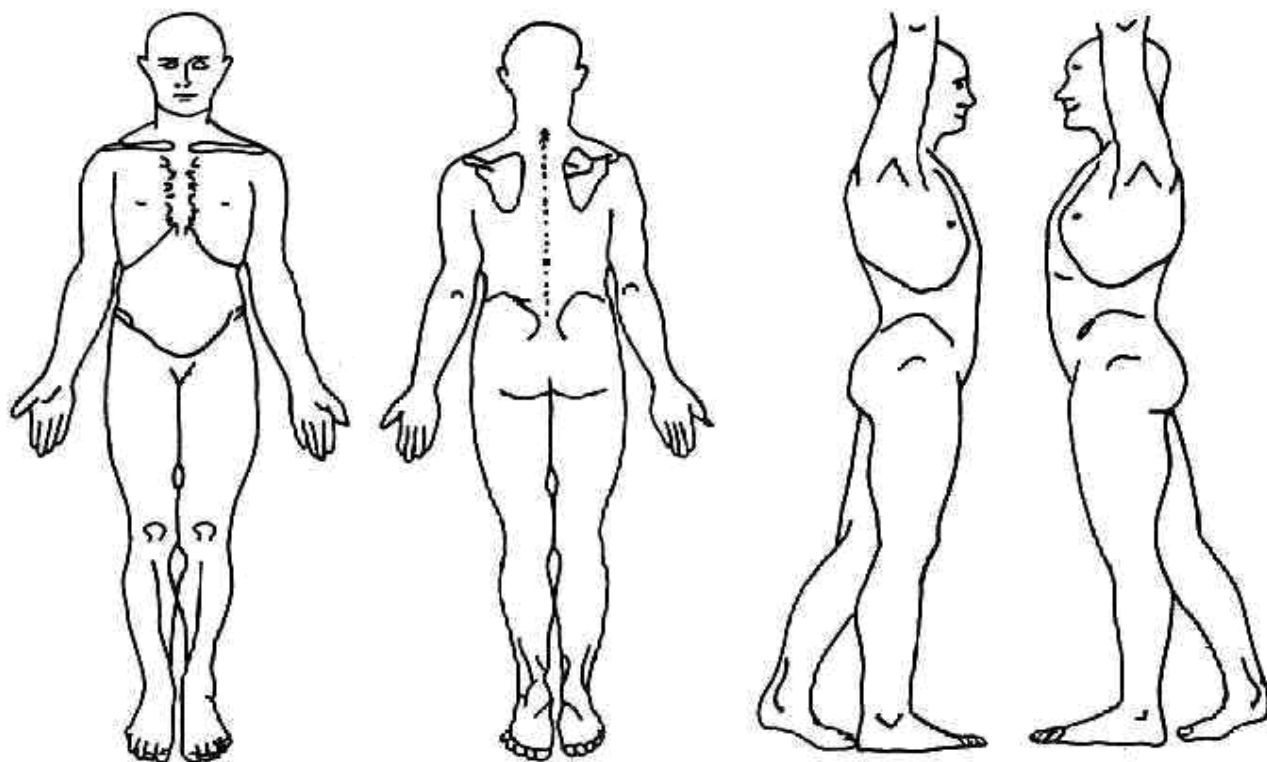
- a. **Pillow** (size and content):
- b. **Bed mattress** (age and firmness):

-
- c. **Sleeping position:**
 - d. **Glasses** (when used, last optometry appointment or script change, when due for another change?)
 - e. **Driving, carrying, sleeping, working, reading, other (if not already discussed)**

19. Special investigations;

20.

Area of Symptoms:



Area	Area	Area
Nature:	Nature:	Nature
Severity:	Severity	Severity
Constant:	Intermittent	Intermittent

Behaviour of Symptoms: specify 'work days' and 'non work days'

	AREA 1 (Area 2 and 3 more intermittent but behavior as for Area 1)
24 HR PATTERN Night: Waking up and daily pattern	

AGGRAVATING FACTORS	
RELIEVING FACTORS	

The Generic Condition Screening Tool

Thinking about the **last 2 weeks** tick your response to the following questions:

		Disagree 0	Agree 1
1	It's really not safe for a person with (neck and upper back symptoms) a <i>condition</i> like mine to be physically active	<input type="checkbox"/>	<input type="checkbox"/>
2	Worrying thoughts have been going through my mind a lot of the time in the last 2 weeks	<input type="checkbox"/>	<input type="checkbox"/>
3	I feel that my (neck and upper back symptoms are terrible) problem is terrible and that it's never going to get any better	<input type="checkbox"/>	<input type="checkbox"/>
4	In general in the last 2 weeks, I have not enjoyed all the things I used to enjoy	<input type="checkbox"/>	<input type="checkbox"/>

5. Overall, how **bothersome** have your neck and upper back symptoms been in the last 2 weeks?

Not at all	Slightly	Moderately	Very much	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	0	0	1	1

Score _____

Physical Examination

Observation:

Functional demonstration of most problematic movement, if applicable:

Movement Tests (record ROM, quality of movement through range and end feel, overpressure where applicable, pain response):

Palpation:

Hypothesis:

Appendix 9: Participant Workstation Measurement

Workstation Adjustment – Participant 1 (18/3/2014)

The following measurements need to be made at each workstation:

Measurement	Mm
Habitual chair seat height(centre of front edge of seat pan to ground) SH(h)	
Habitual VDT height (top of monitor to floor) VDT(h)	
Table height	
Elbow to chair height	
Eye to chair height	

The following can now be calculated:

Measurement	PC-SAFE calculation	Mm
Elbow height	Table height + 25 mm	
Adjusted chair seat height SH(a)	Elbow height - Elbow to chair height	
Adjusted VDT height VDT(a)	Eye to chair height + chair seat height	

Appendix 10: Outcome Measures Questionnaire

Outcome Measures Questionnaire

Date: _____

Dear _____

1. Please mark your average pain intensity in the neck and upper back over the previous two days by placing ONE 'X' on the line.

No Pain

Worst Possible Pain

2. Please mark your average "comfort level", while sitting at work over the previous two days, by placing ONE 'X' on the line.

Very Comfortable

Extremely Uncomfortable

3. Have you taken any medication for your neck or upper back pain over the previous two working days?

Yes	No
-----	----

If you answered Yes, what medication have you taken and how frequently have you taken it?

What effect has this pain medication had?

Please place this form in the sealed box. Thank you for your time.

Appendix 11: Phase End Questionnaire

Phase End Questionnaire

(Please complete this questionnaire in addition to the 'Outcome Measures Questionnaire')

Dear _____ Date: _____

<p>1. Have you been absent from work in the past 4 weeks?</p> <p>If yes, which dates were you absent?</p>	<p>Yes</p>	<p>No</p>
<p>2. Have you received any treatment (such as physiotherapy, chiropractic or other) for your neck or upper back pain over the past 4 weeks?</p> <p>If yes, what treatment have you received? What effect has this treatment had?</p>	<p>Yes</p>	<p>No</p>
<p>3. Have you made any adjustments to your workstation over the past month?</p> <p>If yes, please describe the adjustments that you have made.</p>	<p>Yes</p>	<p>No</p>
<p>4. Is there anything else that you think may have influenced your neck or upper back pain/comfort in the past 4 weeks? (e.g. a change in the work</p>	<p>Yes</p>	<p>No</p>

environment, changes at home, an accident, etc.) If yes, please specify		
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Please place this form in the sealed box. Thank you for your time.

Appendix 12: Exit Questionnaire

Exit Questionnaire

(Please complete this questionnaire in addition to the 'Outcome Measures Questionnaire')

Dear _____

Date: _____

<p>1. Have you been absent from work in the past 4 weeks?</p> <p>If yes, which dates were you absent?</p>	<p>Yes</p>	<p>No</p>			
<p>2. Have you received any treatment (such as physiotherapy, chiropractic or other) for your neck or upper back pain over the past 4 weeks?</p> <p>If yes, what treatment have you received? What effect has this treatment had?</p>	<p>Yes</p>	<p>No</p>			
<p>3. Have you made any adjustments to your workstation over the past month?</p> <p>If yes, how did you change your workstation? (please tick the appropriate box)</p> <table border="1" data-bbox="193 1350 1147 1453"> <tr> <td data-bbox="193 1350 512 1453"> <p>Back to my original settings</p> </td> <td data-bbox="512 1350 831 1453"> <p>Back to the adjusted settings for the study</p> </td> <td data-bbox="831 1350 1147 1453"> <p>Other change</p> </td> </tr> </table> <p>If you chose 'other change' please describe what changes you made:</p>	<p>Back to my original settings</p>	<p>Back to the adjusted settings for the study</p>	<p>Other change</p>	<p>Yes</p>	<p>No</p>
<p>Back to my original settings</p>	<p>Back to the adjusted settings for the study</p>	<p>Other change</p>			
<p>4. Is there anything else that you think may have influenced your neck or upper back pain/comfort in the past 4 weeks? (e.g. a change in the work environment, changes at home, an accident, etc.)</p> <p>If yes, please specify</p>	<p>Yes</p>	<p>No</p>			
<p>5. Has the nature of your work changed over the past 3 months?</p>	<p>Yes</p>	<p>No</p>			

If yes, please specify		
6. Has your physical work environment changed over the past 3months (e.g. a change in the lighting, desk, chair, computer, mouse or other equipment)? If yes, please specify		
7. How frequently do you take breaks from your sitting work	Every 2hours	Less than 2hours
8. Have you changed the frequency of your physical activity (exercise) in the past 3months? If yes, please specify		
9. Has there been any major changes in your family and social life in the past 3months? (e.g moving house, changes in important relationships) If yes, please specify		
10. Have you had any accidents or injuries that may have affected your neck or upper back in the last 3months (e.g. whiplash accident or fall)? If yes, please specify		
11. Have there been any changes in your general health in the past 3months? If yes, please specify:		
12. Have you changed your mattress in the past 3months? If yes, please specify:		
13. Have you changed your pillow in the past 3months? If yes, please specify:		
14. Have you changed your glasses prescription in the last 3months?		

If yes, please specify:

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Thinking about the **last 2 weeks** tick your response to the following questions:

		Disagree 0	Agree 1
1	It's really not safe for a person with (neck and upper back symptoms) a <i>condition</i> like mine to be physically active	<input type="checkbox"/>	<input type="checkbox"/>
2	Worrying thoughts have been going through my mind a lot of the time in the last 2 weeks	<input type="checkbox"/>	<input type="checkbox"/>
3	I feel that my (neck and upper back symptoms are terrible) problem is terrible and that it's never going to get any better	<input type="checkbox"/>	<input type="checkbox"/>
4	In general in the last 2 weeks, I have not enjoyed all the things I used to enjoy	<input type="checkbox"/>	<input type="checkbox"/>

5. Overall, how **bothersome** have your neck and upper back symptoms been in the last 2 weeks?

Not at all

☐

0

Slightly

☐

0

Moderately

☐

0

Very much

☐

1

Extremely

☐

1

Score: _____

Please place this form in a sealed box. Thank you for your time.